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DEVOTED TO CIVIL ENGINEERING
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Editor

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State and Federal Reclamation

A SHARP diatribe against state land reclamation marks the message of Governor Hartley, of the state of Washington, to his legislature. He says that the state reclamation act of 1919—this is the curious bond-purchase act, authorizing the state to buy bonds of private irrigation projects—has not only failed to contribute to the welfare of the people but has "pauperized and bankrupted rather than enriched and benefited." The act provides that bonds of any reclamation district found to be financially sound may be purchased at 90, on a six per cent interest rate. Governor Hartley denounces the act as fallacious and futile on its face, but he rather spoils the argument by saying that any project that can pay on this basis will find any amount of private capital eager for investment, for this was not the case with the Washington districts whose bonds the state purchased. On these purchases, he asserts, the state has already lost one and a half millions, more than 50 per cent of its investment. From these criticisms he proceeds to denounce all state participation in reclamation, and by inference to ask that private enterprise be depended on for the unprofitable work of irrigation development and settlement. Had the Governor protested last summer when the state clamored for federal development of the Kittitas project by the Reclamation Bureau against the clear instructions of Congress, his present declaration would carry more conviction. To the best of our knowledge he made no protest. If the real meaning of the argument in his message is that he objects to risking state money on reclamation but is willing to have Uncle Sam hold the bag, his attitude is in harmony with that of many Western politicians. But we doubt that Congress will long continue to support this attitude. Time shows ever more strongly that reclamation is almost wholly a local problem, whose essential responsibility rests on the state.

Out of Its Element

RATHER interestingly in contrast to the current declarations against federal interference with state duties and functions is a passage in the annual report of the Bureau of Standards, just issued, which states that the bureau has prepared and is now preparing certain legislation to be passed by state legislatures in order to permit cities to carry on city planning. Uniform state legislation is an ideal—from some points of view and for certain purposes—but to have it procured by the endeavors and propaganda of a federal bureau is a rather far departure from our early principles of governmental relations. Governor Hartley's reflection, in his message to the legislature of the State of Washington, that "state interference in reclamation retards rather than hastens development" might be adapted to the present matter by changing it to read, "Federal interference in state legislation retards rather than hastens the development of sound state laws." And incidentally what has the Bureau of Standards, a scientific body if there ever was one, got to do with so controversial a political issue as the relations between city administration and state legislation?

Sludge Utilization Prospects Brighter

PROSPECTS for the utilization of sewage sludge are brightening, according to the data and conclusions presented in identical committee reports before the recent conventions of the American Public Health Association and the American Society of Municipal Improvements, given on p. 836 of our issue of Nov. 19. As would be expected, this is particularly true of the output of activated-sludge plants, although the problems of dewatering are more serious there than with Imhoff or other settling tanks. Since so much apparently yet remains to be done before sludge utilization can be regarded as being on an every-day basis, it is fortunate indeed, that the problem is being so diligently and intelligently tackled as it is by the engineers and chemists of Milwaukee, the Chicago Sanitary District and Indianapolis. For the immediate future and perhaps for some years to come, it seems likely that at relatively large sewage-works, only, can much be expected in the way of the commercial production of sewage sludge, except that at an increasing number of the smaller plants near-by farmers and market gardeners may be induced to remove the sludge and pay small amounts for it. As time goes on and the mere getting rid of sludge becomes more of a problem, many cities of the smaller cities, at least, may consider themselves fortunate if they can get it hauled away without charge on either side.

Expensive Garages

SIR HENRY MAYBURY, the British Director-General of Roads, spent some time this summer studying the road and traffic problem in this country. One of his observations, recently made to a British engineering society, has the pertinence of shrewd observation coupled with a freshness of view that we who have been growing up with the problem possibly can not claim. "One of the great troubles in America," he said, "is to be found in the difficulty of finding room to park the vehicles in the streets and highways. It is no uncommon thing to find in big centers of population during the dormitory hours cars packed in the street continuously four deep, leaving only just room for a single line of traffic to pass between. . . . A more expensive garage cannot be conceived. . . . I expressed surprise that the authorities were content to spend such vast sums of money upon pulling down property and the enlargement of streets and then allow them to be made into garages for motor cars when accommodations for

these vehicles could be provided elsewhere at probably one-twentieth of the cost." This observation is incontrovertible. The object of a street is to provide space for movement and that object is defeated in every busy street in every town and city in the country. Planning for relief always contemplates widening of the roadway or opening new roadways, but either method contemplates, too, the using of part of the enlarged space for storage. How often does the community ever consider the relative cost of providing storage by some other means and thus enlarging the movement space automatically. Custom is against the use of government funds for the expropriation of hitherto privately owned land for mere storage, though such expenditure for movement facilities is well established. Have we not reached a period in urban transportation when a radically new view of the city's obligations is required?

Railway Electrification Without Wires

RAILROAD electrification has taken a new turn. This has been brought about by the perfection of oil-electric locomotives to a point where they can be substituted for steam locomotives in switching service. The possibilities of such locomotives for use in and around cities, where steam locomotives are objectionable because of their noise, smoke and dirt, are indicated by the fact that the New York Central Railroad proposes to use them for all switching work on Manhattan Island below its 72nd Street yards, a section of New York City where its tracks are at street grade and located in a large part directly in the streets. Electrification of these, and all track in New York City, was ordered two years ago by the Kaufmann Act passed by the New York State Legislature, but their electrification by the ordinary means, either overhead trolley or third rail, was out of the question as long as the tracks remained at level and it has been impossible to come to any agreement as to constructive procedure.

Because of this new development, electrification can be accomplished simply through the replacement of a few steam locomotives with the new locomotives in which an oil engine driving an electric generator provides the motive power. The New York Central plan has been approved by the New York State Public Service Commission and so it appears that the use of oil-electric locomotives is considered by the commission to fulfill the requirements of the Kaufmann Act. What can be done under the exacting conditions on the West Side tracks at New York can be done elsewhere in both freight and passenger service, wherever the extent of the territory affected by the objectionable features of steam locomotives is sufficiently great to warrant a change of locomotives upon entering the territory. Passenger terminals in the larger cities can obtain many of the advantages of electric operation through the use of oil-electric locomotives, and at a considerably reduced cost.

The oil-electric locomotive has the power range of the electric locomotive, is not noisy, although not as silent in operation as an electric locomotive, and gives off no more smoke than an automobile. It should be able to operate underground for short distances and into closed terminals if a small amount of ventilation is provided. Its possibilities under such conditions, if not as a substitute, at least as a preliminary step toward electrification, are enormous.

Duralumin and the "Shenandoah"

FACT has fared rather poorly as against sentiment and psychology in the official inquiry on the wreck of the airship "Shenandoah." The vital question of whether the ship was weak, and whether or not it was mishandled in view of its weakness, has been quite forced aside by the welter of What he said and What she said, and embattled opinions over whether an officer and a gentleman should or should not prepare canned testimony. And, finally, a matter of vital importance to engineering and aeronautics even apart from its direct relation to the fate of the "Shenandoah," namely, the deterioration of the duralumin of which the airship's frame was built, has been effectively buried, to the misinformation of the public.

It was testified by engineers of the Bureau of Standards, who had tested pieces of metal from the wrecked ship's framework, that no fatigue of the metal or other harmful effect of the vibratory stresses in the framework of the ship was evident, and that the condition of the metal had not changed in such a way as to lower the strength of the ship. The correctness of this testimony is not open to doubt, but its limited scope must be regretted. Framed presumably in answer to a specific, narrowly defined question put by the Court of Inquiry to the test engineers, it conceals important observations on the deterioration of duralumin.

If we are not mistaken, the physical tests showed a grave reduction in ductility—or, more simply, *toughness*—of the duralumin since the vessel was built. With no marked change in the ultimate strength of the metal, its bending resistance was lowered; a strip bent into a curve cracked at an earlier stage of the process than fresh material. Some of the metal could be seen by the naked eye to have undergone surface corrosion, while other pieces did not; pieces of both kinds, however, showed that virtually everywhere the duralumin was disintegrating, from the surface toward the interior, by the process of progressive cracking, sometimes called season-cracking, almost exactly as cold-worked brasses have cracked and gone to pieces in many unfortunate construction experiences in the past. In brief, the material was growing brittle and its crystal structure was breaking up, the latter most probably being the cause of the former. These facts, of possible bearing on the condition and fate of the "Shenandoah"—all of the preceding applies to metal taken from the framework of the "Shenandoah" as well as to most other duralumin—and even more surely to all future airship construction of duralumin, appear to have been withheld from public knowledge by the Court of Inquiry.

We do not pretend to guess why this was done. Nevertheless, engineers who are interested in structures, and all who are interested in aircraft, may make mental note of these four points as important facts concerning the "Shenandoah's" wreck: (1) That the ship as designed was too weak to resist the severest weather conditions, and that its designers knew it to be thus weak—this we pointed out some weeks ago; (2) that the directing officials and personnel of the Navy, though they had this knowledge at their command, utterly disregarded it in dealing with the "Shenandoah" as though it were an all-weather ship; (3) that this reckless treatment extended to the point of making the ship dangerous by alterations never contemplated by the designers; and (4) that slow but certain disintegration of the ship was

going on, of which the Navy Department had knowledge some months before the disaster, and that this deterioration would in time have made the vessel worthless.

One further point is of interest in connection with this embrittlement of duralumin. Some few parts of the frame material appeared to be free from the action. The best present guess is that these parts were subjected to a heat treatment after they were formed, and that this heat treatment saved them from the slow destruction which attacked the other parts of the metal. Material not heat-treated appears to be subject to progressive embrittlement accompanied by cracking that works its way in from the surface, regardless of whether the material is in service involving stress, or whether it is merely resting in storage. In all probability it is a matter of intergranular atmospheric attack coupled with cold-working stresses and is not connected with the mechanical stresses acting in the material under load.

If such decay of the material cannot be prevented, duralumin is hardly fit for practical use, but should be ranked as a curiosity of the scientist rather than a material of engineering. We have strong hope that it can be overcome. Very substantial and convincing proof of the completeness of the cure is necessary, however, to clear the material of its present charge of being dangerous.

Business and the Engineer

THESE days when the President speaks the whole country listens. Presidential speeches, therefore, thanks to the radio, have in addition to the old-time value as announcements of administration policy a novel potentiality as a molder of common thought. For that reason, as well as for its content, the speech by Mr. Coolidge at New York last week was important. The President said nothing that went counter to his well known policies but he did express those policies clearly, and at times eloquently, so that the American public, listening in, could learn, where it was uninformed, or be persuaded, where it was dubious.

The burden of the President's remarks was a plea for a just weighing of the rights and privileges of business, so called, under a progressive government. The word "business" has been made to cover a multitude of sins, varying from the common application to the mere act of sale to the robber baron connotation that goes with the adjective "big" when applied to the word. Mr. Coolidge defined business more justly. It is, he said, "the mutual organized effort of society to minister to the economic requirements of civilization. It is an effort by which men provide for the material needs of each other. While it is not an end in itself, it is the important means for the attainment of a supreme end. It rests squarely on the law of service. It has for its main reliance truth and faith and justice. In its larger sense it is one of the greatest contributing forces to the moral and spiritual advancement of the race."

Business so defined, it will be seen, includes all industry, all of the manifold ways whereby men do that most necessary thing in this world, earn a living. And being thus universal it merits from the government which is the creature of us all the kinder view that marks the policy of the present administration at Washington. The President would have the government maintain a nice balance which would on the one hand prevent monopoly and restraint of trade and on the other hand avoid regulation to the point of restriction of private initiative and opportunity. Mere bigness is no longer to be considered synonymous with criminality nor industrial success a signal for prosecution. The profit to the community is to be weighed when the possible undue profit of the individual is being contemplated. A reasonable view of the economic interrelations of men has supervened at Washington.

To this program of liberal interpretation of the attitude of the government toward business the President added the constructive program of economy and increased production, through reduction in waste. The former he has no need to emphasize, because it is the foundation of his well known popularity. The latter, however, the people do not yet fully understand, though it has been the policy of the Secretary of Commerce through two administrations. That it is now being taken up by the President himself is a hopeful sign for engineers, because the program which Mr. Hoover set himself five years ago was not only inaugurated by that excellent engineer but is, in effect, an engineering program.

Read what the President outlines for this policy: "We need further improvements in transportation facilities by development of inland water-ways; we need railroad consolidations; we need further improvement of our railway terminals for more economical distribution of commodities in the great congested centers; we need reorganization of government departments; we need still larger extension of electrification; in general, we need still further effort against all the various categories of waste which the Department of Commerce has enumerated and so actively attacked, for in this direction lies not only increased economic progress but the maintenance of that progress against foreign competition."

In this constructive policy the hand of the engineer is apparent; it is engineering thinking that has projected it and it will be engineering action that will carry it through. Assuming that the body politic and economic can settle down under the ægis of a calm view of business needs and prerogatives, the President looks forward to a better time when those things the engineer plans for the future become facts and not plans. No Chief Executive has before so magnified the importance of the engineering view in public affairs.

The engineer is popularly supposed to be a poor business man, particularly by the business man himself. Here is doctrine to the contrary, doctrine that Mr. Hoover has been teaching the country for years—that the necessary improvements in business and through business in the whole texture of the community must come through those basic efforts that the engineer is best fitted to conceive and to direct. If business, freed from harassment by government, as it will be for the three more years of this administration at least, and moved by the saner view of its obligations and responsibilities which has marked its reception of the friendly advances of government, now takes the additional suggestion of the President to consider, and act on, the advice of the engineer in those broader matters which concern production and distribution, the even curve of prosperity should continue to rise to confound those pessimists who arguing from natural law that all things must eventually come down spend their time seeking the reasons why prosperity, too, must soon come to an end.

Rebuilding Old Sewage-Works in Borough of Brooklyn

Tanks Made Over for Riensch-Wurl Type Screens—Excess Storm Flow Diverted Through New Outfall—New 26-Ft. Diameter Screens Installed

RECONSTRUCTION of the old 26th Ward sewage-works in the Borough of Brooklyn, New York City, to effect a change from chemical precipitation to fine screening is practically complete. The screening will constitute a preliminary to a more complete sewage treatment, the method and details of which are now under study.

The old 26th Ward sewage-works was built in 1895 and like two earlier plants (Coney Island and Sheepshead Bay), built in the southern part of what is now the Borough of Brooklyn, used the J. J. Powers process of chemical precipitation and sludge disinfection (see articles on White Plains and Sheepshead Bay plants, *Engineering News*, Sept. 22 and 29, 1892). The present article describes the changes that have been necessary in order to utilize the existing 26th Ward tank and building as a pumping station and fine screening plant.

Original Plant—The old plant was built upon a pile foundation since the surrounding ground was a marsh subject at times to tide flooding. Of four concentric brick walls (Figs. 1 and 2) forming the chemical precipitation tank and a central pump well, the inner and outer were also bearing walls for the roof trusses.

Both dry weather and storm flow were brought to the plant through a twin combined sewer, each part of which was approximately 12x8 ft. in cross-section. The twin sewer emptied into a large basin located just outside of the building; from this basin normal flow was through the tanks in the main building, and the excess flow was diverted into the outfall sewer. A screen house containing two 14-ft. Riensch-Wurl screens, placed some time subsequent to the initial construction, and a small laboratory building were located directly over the basin. These screens had treated a portion of the sewage for a number of years and were still in good condition. Under the new plan, they have been moved into the main building and the screen house is to be utilized as an electrical power house.

In the main building, the chemical precipitation tank was in duplicate with the division wall on the diameter. The effluent discharged over a weir into a chamber from which it was siphoned into the pump well. Two 10-m.g.d. pumps lifted the effluent from the pump well to the outfall sewer emptying into Jamaica Bay about a half mile distant. The nominal capacity of the plant was 7½ m.g.d. The flow had increased to about 30 m.g.d. in 1922 with the prospect of reaching 80 m.g.d. by 1955. Besides its lack of capacity, the plant was out of repair and out of date.

Drawings and specifications were prepared for two optional plans for a plant with a screen capacity of about 80 m.g.d. and a pumping capacity to meet present requirements of 60 m.g.d., upon which bids would be received, the bidder submitting his price upon whichever plan he chose. Each plan provided for remodeling the existing building and installing a complete treatment and pumping plant. Project A called for fine screens of the Riensch-Wurl type, the patent on which has recently expired. Project B called for sedimentation tanks, separate sludge digestion tanks and sludge drying beds. No bids were received for project B and the contract was let for project A at a lump sum of $558,726, there having been three bids on this project.

Reconstruction—Modification and reconstruction have entailed the removal and repair of parts of the concentric walls, the building of new floors, inflow channels, sewer outfalls and appurtenances, the removal into the main building of the two 14-ft. diameter Riensch-Wurl screens existent at the plant, and the installation of two new 26-ft. diameter Riensch-Wurl screens.

The building of new outfalls and appurtenances is an integral part of the reconstruction but has been

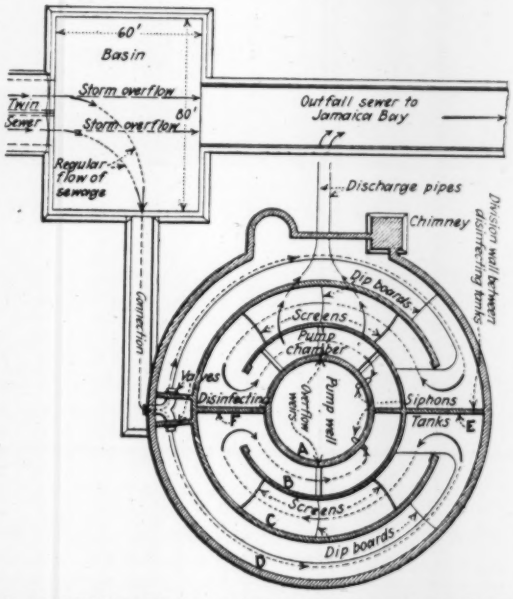


FIG. 1—ORIGINAL PLAN OF 26TH WARD SEWAGE-WORKS

carried out under a separate contract. This work, as shown in Fig. 3, has included the construction of a new storm outfall protected at its lower end with coarse screens and a double set of tide gates, the building of a new sanitary outfall from the southerly end of the existing brick outfall to the outfall canal, the remodeling of the basin and the installing of a diversion weir and equalizing passages between the twin sewers.

The diversion weir with a crest 1 ft. above the floor in one side of the twin sewer diverts all of the dry-weather flow into the other channel, connecting with the sanitary bypass into the main plant. The present dry-weather flow will require only about half of this weir capacity so that the first part of the storm water will pass through the plant. This feature is important since the first storm water exerts a scouring and cleansing action in the sewer and therefore carries much suspended matter. The equalizing passages can be closed by plank gates.

The storm outfall from the old basin to the outfall canal emptying into Jamaica Bay is composed of four 7½x10-ft. channels. It is of reinforced-concrete construction closed at its lower end with a coarse bar

screen made up of ¼x3-in. galvanized bars. The channel is further closed below the coarse screens by two sets of tide gates. Each set is composed of six timber gates seating on a ½-in. rubber gasket. Two sets of tide gates were believed necessary because of their importance to the operation of the plant, since most of the channels in the plant are at datum while the bottom of the pump well is some 12 ft. below this point. The old outfall sewer was a brick structure emptying into a timber flume. The new sanitary outfall to carry the discharge from the pumps of the main plant utilizes the brick portion of the old outfall, to which has been connected a new reinforced-concrete section emptying into the outfall canal. Other construction work outside of the main plant has entailed the remodeling of the sanitary bypass leading the sewage into the plant. The side walls, arch and invert of this brick structure have been removed and replaced with a concrete conduit resting on the existing pile foundation.

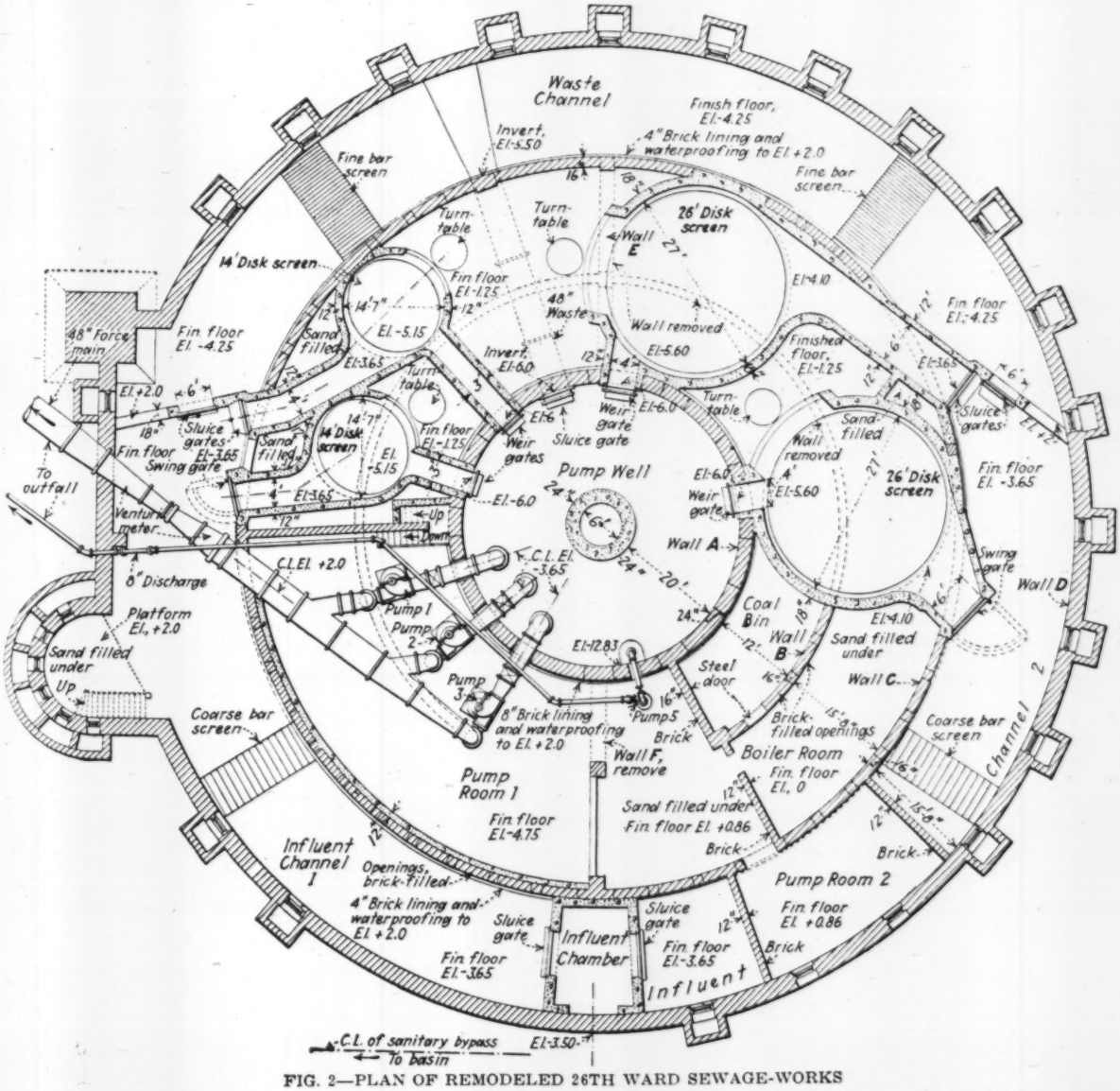


FIG. 2—PLAN OF REMODELED 26TH WARD SEWAGE-WORKS

In rebuilding the main plant, as shown in Fig. 2, wall *B* has been removed where necessary to make room for the screens. New concrete floors have been constructed in the pump well and bottom of the influent channels, rather heavily reinforced on account of the hydraulic and other conditions present. Reinforced concrete was unknown at the time the plant was built and all original construction was of timber and brick. Waterproofing has been used on the floors and for several feet up on the walls. There are still two influent channels as originally, one feeding the 14-ft. screens and the other the 26-ft. screens.

At the entrance of one screen a motor-operated sluice gate is installed to admit the sewage to the screen while on the other a swing gate is used. The flow to both screens can thus be regulated by the one sluice gate. The same arrangement is used for both the 14-ft. and the 26-ft. screens. Coarse bar screens are placed near the entrance to each influent channel to catch all large pieces of waste.

Practically all new construction has been of reinforced concrete, although repairs to existing brick walls

have usually been made with brick and plastered. The wall marked *E* on Fig. 1 has been removed so that the waste channel will be continuous from the end of influent channel 1 to the end of influent channel 2. Other walls have been constructed as shown in Fig. 3 to form boiler rooms, coal bins and a pump room. All of the above-mentioned construction has been done at the elevation of the influent channels and below the main floor.

On the main floor have been built a superintendent's office, a room containing the switchboard and all electrical indicating devices, storerooms, etc. The pump heads are located on this floor as are also a tram track, the motors for operating the sluice and weir gates, and all equipment necessary for removing the solid waste from the screen discharge pits. Further construction involves the placing of a new roof and the repair of the outside of the building to give it a more pleasing architectural appearance.

Equipment—The disk screens are the basic equipment. The existent 14-ft. screens have been equipped for electrical operation, steam having previously been used. The two new 26-ft. screens are believed to be the largest of this type in the United States, although there is an installation of approximately the same size in Germany. These new screens further differ from any previously built in that they are supported at their periphery on rollers. This refinement has resulted in specially rigid equipment that is free from many of the strains experienced in older types. These rollers facilitate the balance of the screens so that a light push with the hand will revolve them. The weight of these heavy pieces of equipment has been distributed over a large area of the slab foundation by means of a heavy reinforcing system. As will be noted in Fig. 4, the radial ribs consist of I-beams. The plates for the screen disk are made of rolled manganese bronze perforated with ⅛x2-in. tapered slots. All screens are cleaned with revolving motor-operated brushes.

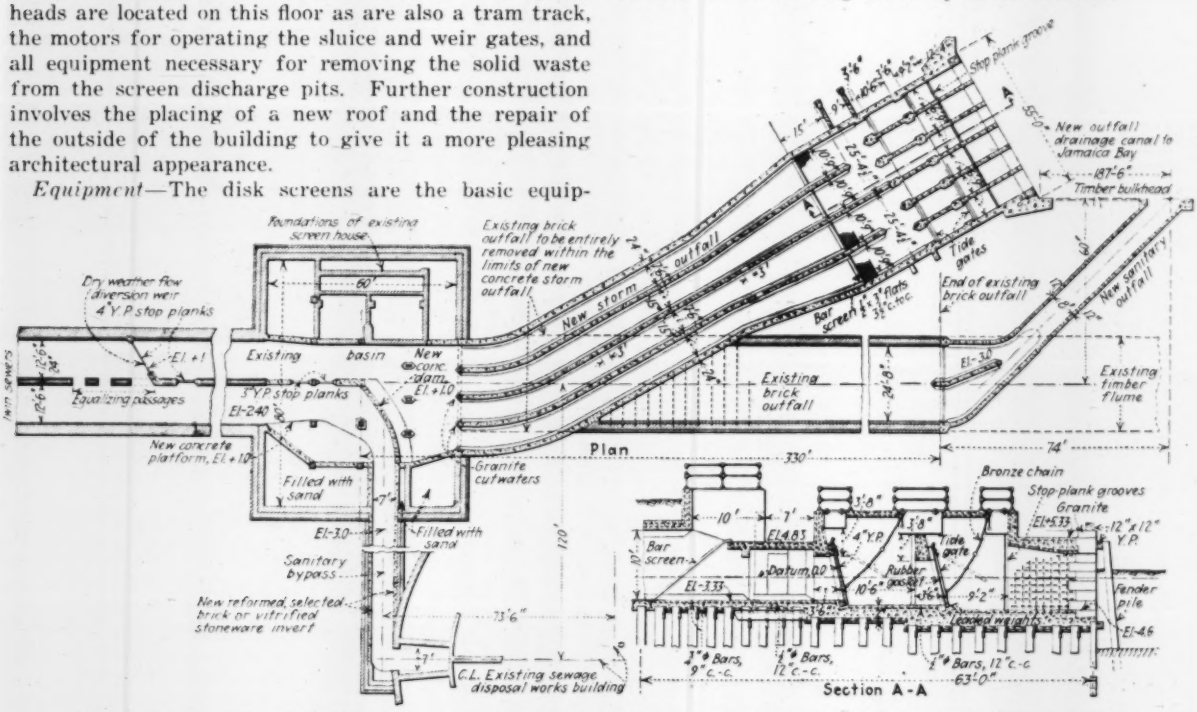


FIG. 3—PLAN AND ELEVATION OF INLET AND OUTFALL STRUCTURES AT 26TH WARD SEWAGE-WORKS

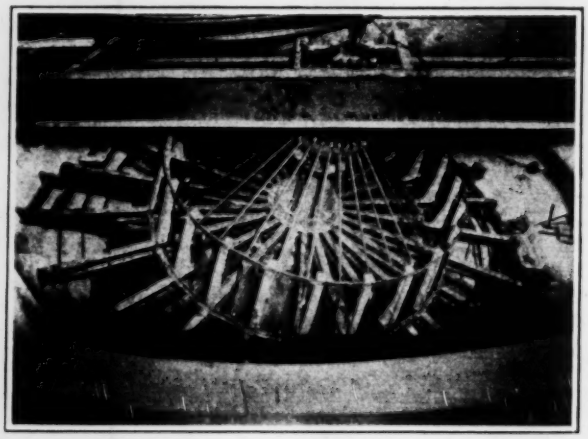


FIG. 4—FRAMEWORK OF 26-FT. RIENSCH-WURL SCREEN

The screens discharge into cans placed on turntables in the sludge discharge pits. The turntables are operated by hand wheels on the main floor. Ten 24x36-in. cans, made of No. 16 gage sheet steel galvanized after fabrication, are to be supplied for each 14-ft. screen, and 15 for each 26-ft. screen. Electric monorail hoisting equipment will be used for removing the cans and conveying them to cars on the tram track. The screenings will be either buried or dumped at sea. The effluent will be discharged into Jamaica Bay until a system of final treatment is provided.

Motor-operated sluice gates are provided at the entrance and end of each influent channel, at the entrance to one 14-ft. screen and one 26-ft. screen, and at the end of the 48-in. waste discharge in the pump well. Motor-operated weir gates opening downward close the openings between the screen pits and the pump well. Three 20-m.g.d. vertical deep-well pumps discharge the effluent from the pump well into the outfall sewer.

Personnel—The work is being done by the Borough of Brooklyn, Arthur J. Griffin, chief engineer of sewers; George T. Hammond is engineer in charge of the design. Niewenhaus Co. of New York is the general contractor and the Shevlin Engineering Co., New York City, has the subcontract for the installation and construction of all mechanical equipment.

Contract Methods in Railroad's Coal Stripping Operations

Northern Pacific Ry. Getting Coal from Deep Cut With Big Electric Excavators and Storage Battery Locomotives

IN prospecting the coal resources tributary to its lines, the Northern Pacific Ry. found that the Rosebud vein of semi-bituminous coal underlies about 700 sq. miles in Montana and an unknown but larger area in Wyoming. This vein, 28 ft. deep, is also underlain for practically its entire area by the McKay vein, the parting between the two varying from a few feet to 20 ft. From an outcrop survey it was estimated that the Rosebud vein had some six billion tons in Montana. The railway owns and operates mines at Red Lodge, Mont., through its subsidiary, the Northwestern Improvement Co., but in view of the possibility of developing a more economical supply of locomotive fuel from the Rosebud field, the chief engineer was directed to make a thorough investigation.

A topographic survey was made of 15 sq. miles near Armell Creek and sufficient borings were made to show the top and bottom of the coal over the entire area. It was estimated that there were in this area 150,000,000 tons having less than 100-ft. overburden, which could be obtained by stripping, and 90,000,000 tons at greater depth, which could be obtained by mining, or a total of 240,000,000 tons. The engineer's report, made in 1919, recommended the building of a branch line up Armell Creek and the opening of a stripping field about 30 miles south of Forsyth, Mont. Tests made on the locomotives indicated that 1 ton of Red Lodge coal was equivalent to 1.4 tons of Rosebud coal. On this basis, and assuming that the branch would not develop other business of any importance, it was estimated that the company would save $700,000 annually by substituting Rosebud coal for Red Lodge coal over the territory between Mandan and Missoula, nearly 800 miles.

This project was not authorized until 1922. The branch line was begun early in 1923 and reached the coal field in December, the terminal point being named Colstrip. Ballasting was deferred until 1924, and the line was turned over for operation on Sept. 1, 1924. In the meantime a shallow test pit was stripped with grading machines and about 45,000 tons of coal were delivered for further tests on the engines, in order to determine the proper draft requirements and firing methods.

Contract Work—As the Northwestern Improvement Co. was not able to handle such extensive excavation,

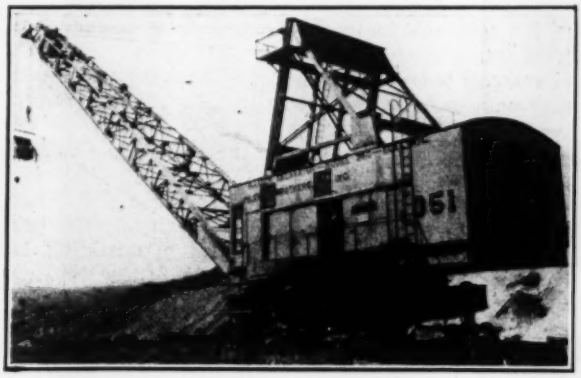


FIG. 1—ELECTRIC STRIPPING EXCAVATOR WITH 6-YD. DRAGLINE BUCKET

it was decided to open the field by contract, but with a view to later development by company force a 5-year limit was fixed for the first contract. In order to permit taking over the work without interrupting its operation, but at the same time to leave the contractor free to select the most suitable equipment, the contract included some unusual provisions for the division between unit costs and equipment costs. Briefly, it provided that the contractor should furnish and install the complete plant necessary for the efficient and economical operation of the field, with the exception of standard-gage locomotives and 56-lb. rail, which were to be furnished by the company and turned over to the contractor.

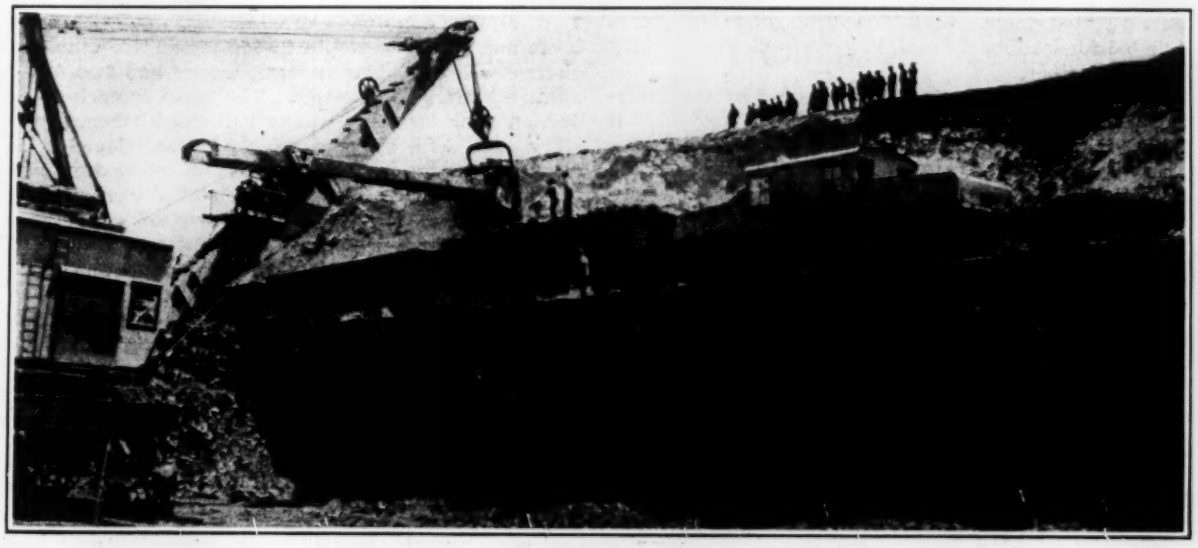


FIG. 2—ELECTRIC SHOVEL LOADING COAL INTO CARS
Cars stand on 28-ft. coal seam. Electric locomotive at right.

Special Features of the Contract—Bidders were given the results of the borings and asked to name unit prices per cubic yard for common excavation, hardpan, loose rock and solid rock, the estimated quantities of stripping specified varying from 500,000 to 2,100,000 cu.yd. per annum. A unit price per cubic yard was to be given also for coal loaded into open-top railway cars. Further, the bidder was required to specify rates per hour for each class of employee he proposed to use on the work. The contract provides that if the engineer finds the current rates of wages for the several classes of labor to be greater or less than those made a part of the contract, the difference found by extending the total roll employed on the work at current rates and at contract rates shall be added to or deducted from the payments to be made the contractors. In other words, the Improvement company agrees to assume the risk of variations in rates of pay throughout the contract period.

The bidder was also required to name a flat lump sum for the equipment complete, specifying the principal items contemplated by his plan of operation, but the responsibility for furnishing the proper type and amount of equipment was to rest solely with the contractor. Payments for equipment would be made by the company in ten semi-annual amounts. The equipment included camps and all appurtenances necessary to put the coal field on a practical and economical operating basis.

In comparing bids, the unit prices for the different classes of excavation of overburden were extended into the classified quantities as determined from the borings, and the unit prices per cubic yard for coal loading were extended into the estimated quantities of coal. To these sums was added the flat sum bid for equipment, and the wage adjustment necessary to put all bids on the same basic wage scale. The total so obtained divided by 4,100,000 cu.yd. gave the amount per cubic yard the company would pay for that amount of coal to be taken out during the contract period. This method completely amortized the equipment in the five-year period. On the basis above described, the difference in total payment for stripping the overburden on the unit prices bid by two firms was only $6,150 on an estimated volume of 6,300,000 cu.yd. of stripping. One bid for loading the coal, however, was substantially below the other.

Electric Power Adopted—The opening of the drainage ditch and of the preliminary test pits showed that no real vein of water was available either above or below the coal seam, and it was decided that electric operation presented the only reliable method of handling the work. As no power line was available nearer than Billings, a distance of 100 miles, it was necessary to make an adjustment in the contract to provide for bringing a power line from Billings and for changing to electrically operated equipment. By bringing the power line through Hardin, about halfway between Billings and Colstrip, it was possible to obtain an intermediate load of fair capacity. By arrangement with the Montana Power Co. the line was constructed through Hardin and power supplied to that point, the Improvement company assuming the cost from Hardin to Colstrip.

Electric Equipment—The contractors then ordered an electrically operated dragline and shovel. This would have left the switching and car spotting to be handled by steam locomotives, the necessary water for their operation being hauled from Forsyth, but as this was both uneconomical and undesirable the contractors determined to use electric locomotives. On account of the objectionable features of either trolley-wire or third-rail on a shovel loading track, it was decided to adopt the storage-battery type of locomotive and two 60-ton locomotives were placed in operation early in June, 1925. Their performance to date is reported as entirely satisfactory, solving what had been a perplexing problem.

Each locomotive is equipped with a car carrying a horizontal reel for an electric cable, so that the batteries can be charged during the time the locomotive is in service, spotting cars at the shovel. As it takes about 1½ hours to load a train, the amount of current which can be stored in the batteries during the spotting

FIG. 3—LOADING A COAL TRAIN
Excavator stands in pit. Cars on track on top of coal seam. Note 60-ton storage-battery locomotive with cable drum on flat car to permit engine to move while batteries are being charged.

period will be more than sufficient to keep the batteries fully and continually charged.

Equipment Plant and Camp—In the plant installed by the contractor the largest item is a 350-ton revolving combined dragline and shovel excavator having a 155-ft. dragline boom with 6-yd. bucket and a 90-ft. shovel boom with 6-yd. dipper; other equipment includes a 175-ton revolving shovel with 75-ft. boom and 7-yd. dipper, a gasoline dragline machine with 60-ft. boom and 2½-yd. bucket, a 20-ton locomotive crane, an electric well drill, two air compressors and two 60-ton storage battery locomotives. The camp comprises two 50-man bunk houses, a dining hall and kitchen, a two-story office with sleeping rooms, a steam laundry, an ice plant, a storeroom with store, a recreation hall, two garages, and cottages for the skilled workmen and their families. The buildings have electric light and steam heat from a central plant. Besides the contractor's camp, the Northwestern Improvement Co. has provided cottages for its employees, an office and a two-room school.

Open-Cut Coal Pit—The pit is approximately 7,800 ft. long and ultimately will be 900 ft. wide, giving about 6,800,000 cu.yd. of coal; the present contract will cover about 6,300,000 cu.yd. of stripping and 4,100,000 cu.yd. of coal. In opening up the pit, the large dragline machine made a stripping cut of 125-ft. bottom width for the entire length. The 7-yd. shovel loads the coal, the machine being at the level of the bottom of the coal seam and the loading track being laid on top of the seam. After making the through cut, the larger

machine was converted into a shovel, making an 88-ft. cut and casting the stripping over the loading track into the pit from which the coal has been removed.

The operations are under the general supervision of C. C. Anderson, general manager of the Northwestern Improvement Co., with Lochren Donnelly as superintendent in direct charge of field operations. All the engineering work for opening and developing this coal field was under the direction of H. E. Stevens, chief engineer of the Northern Pacific Ry.

New Work on Specifications for Materials

Committees of A.S.T.M. Meet in Cleveland to Discuss Research and Revisions of Specifications

AT A group of committee meetings of the American Society for Testing Materials held in Cleveland, Oct. 27-29, the past six months' work in drafting new specifications and revising existing ones was considered, and the associated research work being carried on by the committees was reported on. Some notes of active features of these committee meetings are given in the following:

Steel and Steel Products—In the field of rails, progress has been made in specifications for girder rails by adjusting differences between the society and the American Electric Railway Association.

Structural steel came up for discussion through proposals for unifying the locomotive and car steel specifications, and the bridge and building steel specifications. The committee favors the former proposal, but could not agree on the unification of bridge and building steel, which would involve the elimination of bessemer material now admissible under the building steel specification. The question of undertaking an investigation to determine the feasibility of producing a higher strength structural steel for ordinary use was discussed, without definite result.

A draft specification for cold-rolled strip steel was presented and considered favorably. Changes of form in the pipe and bar steel specifications were discussed. Slight revisions and improvements were made in the specification for pipe fittings and bolting material for high-temperature service, and a draft specification for forged material for high-temperature service was considered.

Wrought Iron—In the study of the effects of annealing, results obtained up to the present indicate that staybolts have their life practically doubled by annealing after threading. The effect of phosphorus in wrought iron is being investigated. Changes in the strength and ductility specifications for wrought iron are in view.

Malleable Castings—Determination of yield point engaged chief interest, due to last year's action fixing an acceptance value for yield point at 30,000 lb. per sq.in. It is now agreed in the committee that the divider method of determining yield point should be specified as an alternate to the drop-of-beam method.

Non-Ferrous Metals—Four or five new specifications have been prepared dealing with aluminum bronze, valve bronze, brass castings, and aluminum-base sand-casting alloys. Much other specification work in this field is in progress, both new and revision.

Corrosion—On the subject of corrosion of ferrous metals, the latest reports from the Fort Sheridan and Annapolis exposure tests of bare iron and steel sheets show that relative corrosion there follows at a slower rate than that exhibited in the Pittsburgh exposure, previously reported with decided advantage of copper-bearing steel over the non-copper-bearing steel. The water immersion tests, as hitherto, give results quite different from those of atmospheric exposure. The committee is now installing the test samples in the elaborate exposure tests of metallic-coated steel which it initiated during the past year. Specifications for galvanized sheets and galvanized wire and pipe are being prepared.

Corrosion of non-ferrous metals, studied by a separate committee, is being investigated by an experimental comparison of four accelerated corrosion tests in several laboratories with a view to determining a single standard corrosion test, if feasible. Two of the laboratories have now completed their comparative tests, and results will probably be reported next summer.

Cement—Comparative studies of compression tests on cement made in various laboratories, which have been under discussion for some time, further occupied the cement committee, but without definite conclusions.

Gypsum Products—Papers on calcium sulphate retarders for portland cement and on the hydration of anhydrite were presented by E. Borger and M. Farnsworth. Studies and tests are in progress under the auspices of the committee to guide in fixing working stresses, writing specifications and recommended practice for structural gypsum products, preparation of field test specimens and the like, in which work the Columbia University laboratory and the Bureau of Standards are assisting. The latter institution supplied data on elasticity and sand-carrying capacity of gypsum and gypsum plaster. Specifications have been drafted for several different kinds of gypsum plasters.

Other Materials—Some research results were presented on coal and coke, and on electric insulating materials, the latter comprising extensive data relating to test methods, chiefly of molded materials. Porcelain and liquid insulating materials are also the subject of active research work. Revisions of various specifications are being considered, where practical difficulties have been found. In the field of rubber products, where performance tests have been a leading subject of interest during the past year or two, a machine for carrying out life tests of belting under flexure has been agreed upon and several such machines will soon be in service.

A new committee began work, dealing with the subject of metals for electrical heating. It will first undertake to study and outline standard methods of testing, preliminary to dealing with quality specifications for the materials.

The Research Committee on the effect of tin and arsenic on high speed tool steels held its first meeting and decided that the first test work should be on three steels, containing respectively no tin and arsenic, 0.50 per cent arsenic, and 0.50 per cent tin.

A Building Demolition Record

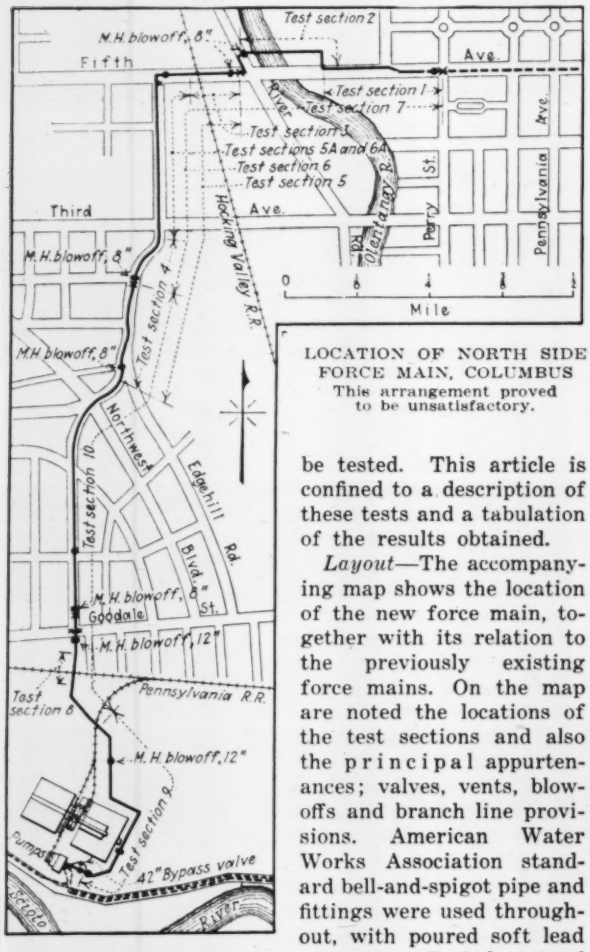
In the process of tearing down the old Hotel Grosvenor at New York City, a 10-story building with brick bearing walls, 81x100 ft., in 17 working days, 4,000 yd. of rubbish, brick and timber were taken out, or an average of 5 cu.yd. per man per day.

Leakage Tests of Cast-Iron Force Main at Columbus, Ohio

Two Miles of 42- and 36-In. Pipe Show Measured Average Leakage of 76.5 Gal. per 24 Hr. per Inch-Mile of Pipe

By John C. Prior
Designing Engineer, Bureau of Water-Works Extension, Columbus, Ohio

COLUMBUS, OHIO, recently put into service a little more than three miles of new cast-iron force main, extending from the pumping station, on the north bank of the Scioto River, some two miles west of the heart of the city, into the northern portion of the city, ordinarily referred to as the North Side. Two miles of this main, consisting of 42- and 36-in. cast-iron pipe, were laid under a contract which required that the line



LOCATION OF NORTH SIDE FORCE MAIN, COLUMBUS
This arrangement proved to be unsatisfactory.

be tested. This article is confined to a description of these tests and a tabulation of the results obtained.

Layout—The accompanying map shows the location of the new force main, together with its relation to the previously existing force mains. On the map are noted the locations of the test sections and also the principal appurtenances; valves, vents, blow-offs and branch line provisions. American Water Works Association standard bell-and-spigot pipe and fittings were used throughout, with poured soft lead joints, the depth of lead being 2¼ in. Each length of pipe and each fitting was supported on 3x12-in. blocking of a length equal to the nominal diameter of the pipe, placed near each end. Four timber wedges were used for final grading and alignment of each casting. The minimum cover over the top of the pipe was 3 feet.

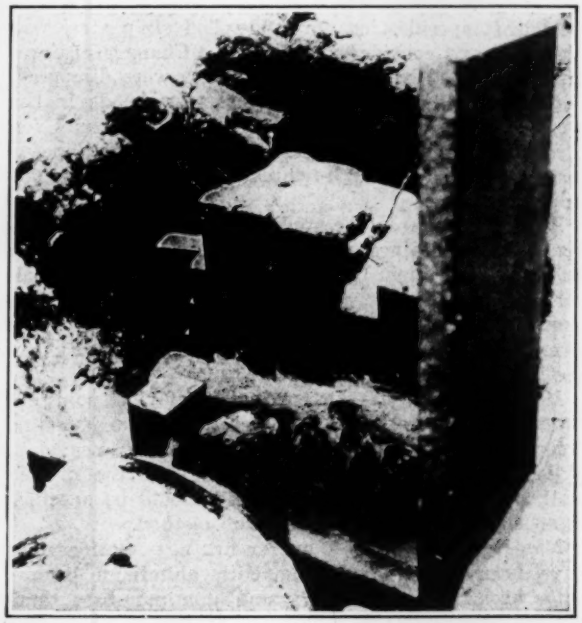
The center line of the pipe ranges from El. 21 to 51. Class "D" pipe was used under all railroads, main lines, sidings and interurbans, and Class "C" for the river crossing; otherwise the line was made up of Class "B" pipe and fittings.

Under the Pennsylvania Railroad the main was carried in a timber-lined tunnel 6 ft. wide by 6 ft. high and 250 ft. long. The Hocking Valley R.R. was also tunneled, its length being 42 ft. At the Olentangy River crossing an ordinary sheeted open-cut trench was used, the minimum cover over the top of the pipe at the deepest portion of the stream being 5 ft. The trench was kept fairly dry by pumping so that no great difficulties were encountered in getting a tight pipe line. There was about 670 ft. of deep line at the river crossing.

In Edgehill Road, from Hilo Lane to Third Avenue, the force main was laid through a swamp. The autumn of 1924 was an unusually dry one so that the ground-water level had fallen until it was only 18 in. higher than the trench bottom. The soil was a black sticky muck of very poor bearing value and exceedingly unpleasant for laborers to work in. As many as fourteen 3x12-in. blocks were used under a single pipe to maintain the grade in this section. Except for the portions just mentioned there were no unusual difficulties.

Leakage Requirements—The specifications required the contractor to leave the line uncovered until after testing. They further required that the main be plugged, filled with water, subjected to a given hydrostatic pressure, and then inspected. Any leaks which appeared were to be stopped by recalking or repouring as the case required. Cracked pipe were to be removed and replaced. No specific amount of allowable leakage was stated, the intention being to stop all visible leaks.

On account of the difficulties encountered in keeping the whole of the pipe line uncovered at the Olentangy River crossing, and because of the desirability of putting certain streets back into service as quickly as possible, it was deemed advisable to modify the contract to allow backfilling of certain portions to proceed with the laying of the pipe. Due to this change in policy it was necessary to fix a limit on the amount of leakage, and if the leakage exceeded this amount the contractor agreed to uncover the line and repair it until the



JACKS AND TIMBERS FOR HOLDING PLUG DURING TEST OF COLUMBUS FORCE MAIN

LEAKAGE TEST DATA, NORTH SIDE FORCE MAIN, WATER-WORKS OF COLUMBUS, OHIO

Test Section Number	Location (See Accompanying Map)	Nominal Diam. of Pipe, In.	Length of Pipe, Ft.	Inch-Miles of Pipe	Joints: Total Number	Joints: Total Length, Ft.	Joints: Length of Pipe per Joint Ft.	Measured Leakage: Per Lineal Ft. of Pipe Gal. per Hr.	Measured Leakage: Per Lineal Ft. of Joint Gal. per Hr.	Measured Leakage: Per Mile of Pipe Gal. per 24 Hr.	Measured Leakage: Per Inch Mile of Pipe Gal. per 24 Hr.	Pressure, Lb. per Sq. In.	Max. Leakage Allowed: Per Lineal Foot of Pipe Gal. per Hr.	Max. Leakage Allowed: Per Mile of Pipe Gal. per 24 Hr.	Max. Leakage Allowed: Per Inch-Mile of Pipe Gal. per 24 Hr.	Remarks
1	In Fifth Ave. to Perry St. valve	36	1,133 5	7.73	96	975.2	11.81	0.0225	0.0261	2,846	79.1	110	0.15	19,008	528	Note No. 1
2	River Crossing	36	851.6	5.81	83	849.0	10.26	0.0552	0.0554	6,994	194.3	110	0.15	19,008	528	Note No. 2
3	Pt. W. of H.V.R.R. to River Rd. valve	36	489.9	3.34	45	459.4	10.89	0.0200	0.0213	2,532	70.3	110	0.15	19,008	528	Note No. 3
4	Edgehill swamp	36	1,386.9	9.46	128	1,300.2	10.84	0.0141	0.0151	1,789	49.7	110	0.15	19,008	528	Note No. 4
5	Hilo Lane to River Rd. valve	36	3,883.7	26.48	347	3,530.2	11.19	0.0534	0.0588	6,774	188.2	110	0.15	19,008	528	Note No. 5
5A	Third Ave. to Pt. W. of H.V.R.R.	36	2,006.3	13.68	175	1,779.6	11.46	0.0888	0.1001	11,255	312.6	110	0.15	19,008	528	Note No. 5A
6	2nd Ave. valve to River Rd. valve	36	2,952.1	20.13	263	2,675.8	11.23	0.0597	0.0659	7,566	210.2	110	0.15	19,008	528	Note No. 6
6A	3rd Ave. to Pt. W. of H.V.R.R.	36	2,006.3	13.68	175	1,779.6	11.46	0.0797	0.0909	10,106	280.7	110	0.15	19,008	528	Note No. 6A
7	River Rd. valve to Perry St. valve	36	2,233.1	15.23	208	2,118.9	10.73	0.0210	0.0222	2,667	74.1	110	0.15	19,008	528	Note No. 7
8	Pennsylvania R.R. Tunnel	42	373.3	2.97	33	395.5	11.31	0.0262	0.0236	3,323	79.1	110	0.175	22,176	528	Note No. 8
9	Pt. S. of Meter to W.P.W. Switch	42	1,800.0	14.32	157	1,849.6	11.46	0.1354	0.1318	17,164	408.7	110	0.175	22,176	528	Note No. 9
		42	987.8	7.86	92	1,094.6	10.74									
10	Water purification works	36	3,293.8	22.46	293	2,976.2	11.24									
	Switch to 2nd Ave. valve	24	46.0	0.21	10	86.7	4.60	0.0573	0.0597	7,264	196.2	110	0.154	19,515	528	Note No. 10
		16	46.0	0.14	9	42.2	5.11									
		42	2,787.8	22.18	249	2,944.2	11.16									
	Average and totals	36	8,479.0	57.82	764	7,770.8	11.09	0.0632	0.0662	8,014	214.4	110	0.156	19,768	528	
	Tests 9, 10, 6 and 7	24	46.0	0.21	10	86.7	4.60									
		16	46.0	0.14	9	42.2	5.11									
		42	2,901.0	23.08	266	3,156.3	10.91									
11	Test of entire line. Venturi and	36	8,479.0	57.82	764	7,770.8	11.09	0.0290	0.0301	3,678	98.3	100				Note No. 11
	Bypass valves to Perry St. valve	24	46.0	0.21	10	86.7	4.60									
		16	46.0	0.14	9	42.2	5.11									
12	Meter test of entire line	As given in Test No. 11						0.0226	0.0234	2,860	76.5	85				Note No. 12

General. Wherever tests were made against valves the leakage through the valves, if any, was not measured.

No. 1. Tested against 36-in. valve at Perry St.; other end plugged. 204 ft. of old 36-in. line included from Perry St. valve westward. All of new line was open and all visible leaks were stopped by recalking. Measured leakage in one hour, 25.46 gal.

No. 2. Tested with plugs at both ends. About 500 ft. of line was exposed. The timber and jacks holding the plugs partially failed causing a joint to slip at each end. One joint opened ¾ in. and the other 1½ in. These joints leaked considerably during test but no measurement was made of exact amount. The two joints were afterwards burned out and repoured. This section included Olentangy River crossing. Measured leakage in ½ hr., 23.5 gal.

No. 3. Tested against 36-in. valve at River Rd.; other end plugged. Line about 90 deg. visible. Included tunnel under Hocking Valley R.R. Measured leakage in 1 hr., 9.79 gal.

No. 4. Tested with plugs at both ends. The greater portion of this section was in a swamp. A little more than one-third of this line floated in the trench during a severe night rain storm but was recalked before this test. The greatest vertical displacement of any portion of the line was about 30 in. while floating and about 6 in. after subsidence. About half of the pipe line was exposed during the test. Temperatures before and during the test were below freezing. Measured leakage in 1 hr., 19.58 gal.

No. 5. Tested against 36-in. valve (River Rd.) and plug at south end; also, branch at Fifth Ave. was plugged. This test included both Sec. 3 and 4. All of line was backfilled. Measured leakage in 1 hr., 207.6 gal.

No. 5A. Leakage here calculated for portion not included in tests 3 and 4 by assuming that leakage in sections 3 and 4 was the same as in previous tests. Calculated leakage in 1 hr., 178.2 gal.

No. 6. Tested between River Road valve and Second Ave. valve. Measured leakage in 1 hr., 176.26 gal. Otherwise same as No. 5.

No. 6A. See note on 5A. The leakage in Section 4 was assumed to be uniform per unit of length. Calculated leakage in 1 hr., 160 gal.

No. 7. Tested between valves at Perry St. and at River Road. Whole of line was backfilled. This test included both Sec. 1 and 2 and was intended to cover portions not included in previous tests. Total leakage in 1 hr., the same as that obtained in test 2 (47 gal.). This indicates that the open joints, mentioned in note 2, must have contributed very materially to the total leakage in test 2.

No. 8. Line plugged at both ends. This section included Pennsylvania R.R. tunnel, which was completely backfilled. Measured leakage in 1 hr., 9.79 gal.

No. 9. Line plugged at both ends. Only about 200 ft. of pipe line was backfilled. All visible leaks were stopped before testing. The plug bracing at one end partially failed allowing a joint, under the backfilling, to open 2 in. Doubtless a considerable portion of the total leakage escaped at this joint. The joint was afterwards excavated, burned out and repoured. Measured leakage in 1 hr., 243.8 gal.

No. 10. Tested against 36-in. valve at Second Ave. and plug at other end. A 24- and a 16-in. valve on branches were included. Pipe line from Goodale St. to Northwest Boulevard was open and all visible leaks stopped. Section 8 was included in this test. It was intended to divide this section into two parts by using the 36-in. valve at Goodale St. but unfortunately this valve would not make a tight closure. It was impracticable to repair the valve in time for the tests. Measured leakage in 1 hr., 250.7 gal.

No. 11. Test of entire line between two 42-in. valves, one on main line and the other on venturi meter bypass, at the south end and the 36-in. Perry St. valve at the north end. The pipe line had been under city pressure (about 50 lb. per sq. in., fed from Perry St.) for 48 hr. previous to test and all air vents were showing water. One joint was leaking sufficient water to be visible on top of backfilling (about 3 ft. over top of pipe). This joint was afterwards excavated and made tight. Measured leakage in 1 hr., 333.0 gal.

No. 12. Conditions same as given in Note 11. This was a six-day test under city pressure. The line was fed through a ¾-in. meter from the pumping station supply line. Pressure given is approximate and doubtless varied considerably during testing time. The pressure at the direct service pumps was 90 lb. per sq. in. Average leakage in 1 hr., 259 gal.

requirements were fulfilled. The original pair of 36-in. force mains to the city, laid in Dublin Avenue, in 1907, were placed under specifications which limited the amount of leakage. These leakage limits were those given in the accompanying table under the heading "Maximum Leakage Allowable," and were to obtain when the line was subjected to a hydrostatic pressure due to a head of water having a free surface at El. 300 city datum, approximately 110 lb. per sq.in. These same leakage limits were adopted for the new work. A description of the tests on the original mains, by John H. Gregory, may be found in the *Engineering Record*, Vol. 65, April 20, 1912, p. 432.

Testing—The sections of the pipe line were filled with water from nearby fire hydrants. A small horizontal steam duplex water pump was used for raising and maintaining the water pressure to and at that specified. The steam pump was not driven by steam however, compressed air being substituted. All the pipe calking was done with pneumatic hammers using air from gasoline-engine-driven compressors. One of these compressors operated the steam pump very satisfactorily, except for the test of the entire main when sufficient power was not available to raise the pressure beyond 100 lb. per sq.in. Although an overall test was not required in the contract, such a test was made by the contractor, hence the engineers had to be content with a pressure 10 lb. under standard.

The suction line from the pump was connected to a steel tank 4 ft. in diameter by 3½ ft. deep. This furnished an acceptable means of measuring the water used to maintain the pressure and was a direct measure of the leakage, provided the line was air free at the beginning of the test. The test pressure, in general, was maintained constant for one hour; the amount of water pumped into the line during this time was measured by noting the drop of the water surface in the suction tank. Readings of the amount of water used, to the nearest ⅛-in. in the tank, were taken at frequent intervals, generally from 2 to 5 min. These readings indicated whether or not the leakage was at a uniform rate throughout the testing period. The testing pressure gage was set at approximately El. 50 on all tests, making the required pressure about 110 lb. per sq.in. The actual pressure on the line was, therefore, somewhat higher than this amount throughout most of the length, reaching 122 lb. in the lowest stretches.

Holding Plugs—Considerable difficulty was experienced in getting satisfactory bracing and bearing areas for maintaining the plugs or caps in place during tests. The common procedure where they were used

was to stop excavation and use the end of the trench as a foundation. This was squared up, approximately 5 ft. wide by 6 or 7 ft. deep, and lined with heavy timbers. Between this vertical crib and timbers placed against the plug, eight to twelve house jacks were placed. The jacks were screwed up until the bearing area was supposedly subjected to almost full pressure. Probably this was never realized because with few exceptions when the pipe was subjected to the required pressure the joint just back of the plug slipped. The total end thrust on 36- and 42-in. plugs under the pressure used was 67 and 90 tons respectively. The bearing area on the earth was about 30 sq.ft., making the unit pressure 2 to 3 tons per sq.ft. A typical plug bracing is shown in the accompanying view. A more satisfactory arrangement consisted of omitting a short section of pipe, plugging the open ends and bracing one plug against the other, and then proceeding with the pipe laying until sufficient weight of pipe was in place to take the end thrust from the section to be tested.

Test Results—The results of all the tests are given in the accompanying large table and should be used and interpreted in connection with the notes appended thereto. Tests 1 to 11 extended over exactly one hour with the exception of Test No. 2, which terminated at the end of 40 minutes, due to failing plug braces. Test No. 12 extended over six days with the following progressive leakages:

Meter reading time	Leakage Cu.Ft.	Leakage per Hour, Gal.
11:00 a.m. May 19 to 10:45 a.m. May 20	886	279
10:45 a.m. May 20 to 10:15 a.m. May 21	846	269
10:15 a.m. May 21 to 1:20 p.m. May 22	918	253
1:20 p.m. May 22 to 8:15 a.m. May 23	612	242
8:15 a.m. May 23 to 8:45 a.m. May 25	1,643	253
Total and average	4,905	259

As noted elsewhere, numerous intermediate leakage readings during the hourly tests were made. When the leakage was plotted as abscissas against time as ordinates a straight line best represented all points indicating that the leakage for the short time tests was practically at a uniform rate. The progressive improvement in the long-time test seems to be characteristic of experience elsewhere judging from such published data as are available. The retrogression during the last two-day period in the table above may be due to uniformly higher pressure on May 24 (Sunday) than on the other days of the testing period.

If it be assumed that the leakage varies as the square root of the head, which is probably near the truth, all the tests may be reduced to the standard pressure of 110 lb. per sq.in. The average leakage during the six-day test would have been 87.3 gal. per in. diam. per mile of pipe per day had the pressure been 110 lb. per sq.in. and for the hourly overall test it would have been 103.2 gal. Both of the overall tests, reduced to standard pressure, show much less leakage than the summation of the sectional tests (214.4 gal. per in.-mile per day). It is reasonable that there should be a difference, because certain known leaks were stopped before final testing, (see note on Test No. 9) and the possibility of leakage by valves is materially reduced during overall tests.

With the exception of Test No. 9, the measured leakage was well within that allowed, and this section contained a known leak which probably contributed materially to the measured leakage. The calculated leakage is sections 5-A or 6 A must be interpreted in the light of the assumptions made, which may or may not be true. The overall tests indicate that 20 per cent of the maximum allowable leakage would cover the actual leakage at the required pressure.

It would seem that the conclusion might be drawn that the maximum leakage allowed was liberal; that one-half of this amount, (or say 250 gal. per in.-mile per day) could be obtained with little difficulty and that a leakage as low as 100 gal. could be obtained when laying mains under conditions and pressures comparable with those herein described.

Costs—The total cost of the three miles of new main was a little less than $500,000. The pipe and fittings were purchased delivered along the pipe line for approximately $270,000.

Engineering Staff—The work was in general charge of C. B. Hoover, superintendent of the Division of Water. John H. Gregory, of Johns Hopkins University, Baltimore, Md., was consulting engineer. The writer had direct charge of design and construction and the Grant-Boulton Co., of Columbus, general contractors, laid the main.

Pipe Steel Shipped Flat Then Rolled and Welded

Heavy Transportation Cost Avoided in Securing Materials for Laying 8-Mile 30-In. and 24-In. Line in Oregon

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Great distances are often the controlling factor in the purchase of construction materials. Heavy transportation cost makes some commodities practically prohibitive—large-diameter steel pipe for example. So when the Portland Gas and Coke Co. decided to lay a new main the engineers were confronted by this old problem, but solved it in a very satisfactory manner, and a most interesting piece of engineering is now rapidly nearing completion—the laying of seven miles of water pipe fabricated on the spot from boiler plate.

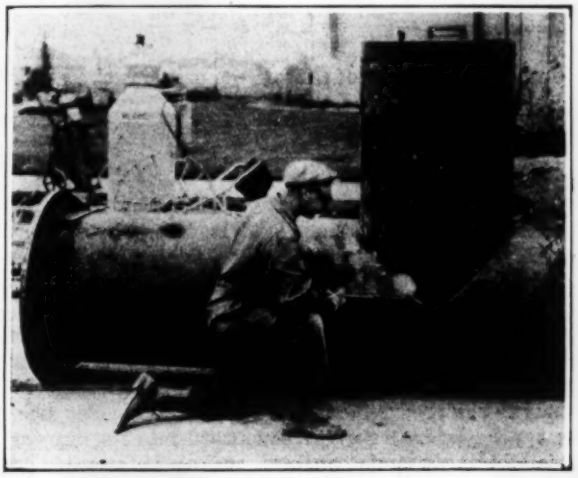
The line is to consist of 16,000 ft. of 30-in. and 26,000 ft. of 24-in. steel pipe. That meant freight on a good many carload lots. But the equivalent amount of flat boiler plate, cut to proper size, could be shipped at a low rate from the eastern mills via the Panama Canal and then made into pipe by oxwelding. Once the pipe lengths were formed, they could be strung along the right-of-way and welded into one continuous piece, all in accordance with a now well-established practice. A little investigation convinced the engineers of the soundness of this plan and an order was placed for the plate.

Two welding contracts were let, both of which were secured by the Steel Tank and Pipe Co., of Portland, Ore. One contract covered the fabrication of the 36-ft. lengths in the shop; the other provided that the gas company was to take delivery of the pipe at the shops, string it, line it up, do the ditching and backfilling; in short everything except the actual welding. The oxwelding was to be done by the contractor at so much per linear foot of welding. If unforeseen conditions arose that would delay the welders, the contractor was to be compensated on an hourly basis.

Operations in the shops began April 15, 1925, and it was anticipated that the entire job would be com-

pleted before Christmas. Since the job was to be so large (it is believed the Portland line is the first of this size and length ever completely fabricated by welding) it was difficult to estimate accurately how much time would be required. Before starting, the Steel Tank and Pipe Co. consulted engineers of The Linde Air Products Co., who had worked out a "procedure control" for fabricating pipe by oxwelding (that is, detailed and carefully prepared set of instructions taking up each individual operation step by step). This procedure control was followed by the contractor to the letter, with a Linde service engineer at the plant to aid in its interpretation and application and to help train the welding operators. As a result of this careful planning the work of fabrication was completed Aug. 1, and the welding of the line in the field finished about Oct. 1. Some delay has been experienced in the pipe laying due to the fact that the trenches encountered a long-abandoned macadam road-bed under the surface, the existence of which had been forgotten. This hard layer slowed down the ditching operation to about 500 ft. per day.

The plates, which were ⅜ in. thick and came in 12-ft. lengths, were first beveled on the sides and ends to an angle of about 45 deg. to form the vees for welding. They were then passed through a set of rolls to bend them into rings. It was found that the large rolls would not curve the plates all the way out to the edges so a special roll was rigged up to form the edges before

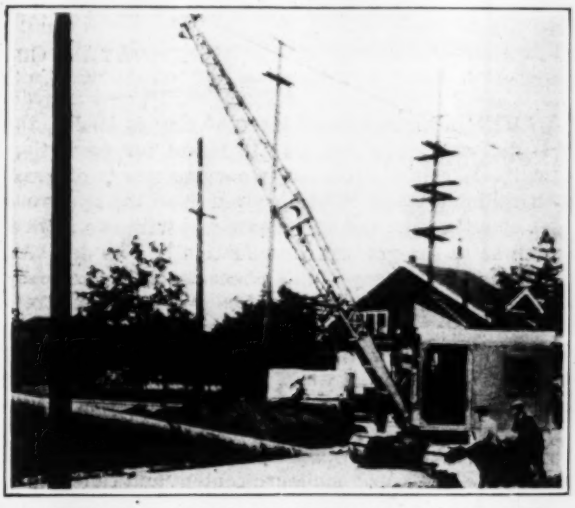


WELDING ON T-SECTION FOR 8-MILE GAS LINE; BRACED FLANGE IS ALSO WELDED

feeding the plates to the large rolls. After the longitudinal seams had been welded, three of the courses of rings were lined up on rollers and the circumferential seams welded, thus forming a 36-ft. length of pipe. The work was continuously rotated so that the weld was always in a convenient position for the operator. The welding crews consisted of 7 men on the longitudinal seams and 4 men on the circumferential seams.

After the 36-ft. lengths had been fabricated they were transported to the yard for test on a narrow-gage track. They were first subjected to 150-lb. hydrostatic pressure and while the pressure was still on the welds were hammered with a 12-lb. sledge. The water was then drained and the lengths given an air test of 50 lb. Soapy water was applied to the welds with a paint brush to locate any leaks that had developed under the hydrostatic pressure. Of the hundreds of joints tested, but very few leaks appeared and they were mere pin holes that were closed by calking. Only three joints were returned to the shop to be rewelded.

From the testing department the lengths were shunted to the dipping tanks, where they were passed in succession through hot alkali solution to remove



LAYING SEVERAL LENGTHS OF ALL-WELDED PIPE

grease, hot dilute sulphuric acid to clean off scale, an alkaline neutralizing bath and a hot water rinse. Drying by means of gas flames played on the inside of the pipe completed the preliminary treatment. The lengths were then capped at each end, dipped in asphaltum and while still warm rolled in grit, ready for the stringing gang. The caps served not only to keep asphalt from the interior of the pipe but also to leave a 3- or 4-in. band at each end uncoated, to facilitate welding. After welding was completed in the field, this band at the weld was coated with asphalt paint.

There was nothing unusual about the field work in connection with this line. With a crawler traction crane for handling, three 36-ft. lengths were welded into a 108-ft. section on skids over the trench. This section was then tied-in to the pipe line already completed and lowered into the trench. Experience has proved that it is the best engineering practice to offset adjacent longitudinal seams some 120 deg. of arc. The Steel Tank and Pipe Co. recognized the soundness of this principle but after careful consideration decided it would be more desirable to offset the seams only 22½ deg., that is, 14 in. This brought all the seams near the top of the pipe and facilitated final inspection.

This line has been watched with much interest by gas, water, and pipe-line companies on the Pacific Coast, and already several other lines of similar construction are under consideration.

Changing Railway Gages in Australia

The first stage in the scheme for establishing a uniform gage of 4 ft. 8½ in. for the railways of Australia has been begun in the reconstruction of an 85-mile line from Grafton to Kyogle in New South Wales and the construction of a new standard-gage line from Kyogle to Richmond Gap on the border between New South Wales and Queensland and from this point to South Brisbane in Queensland.

Principles of Soil Mechanics: IV—Settlement and Consolidation of Clay

Consolidation the Result of Decrease of Moisture Content Under Load—Change in Hydrodynamic Stress—Typical Computations—Application to Permeability Determination

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WHEN a homogeneous layer of clay is loaded, the deformation of the clay increases for some time after the load is applied. This phenomenon is of great practical importance, being involved in all the numerous cases of settlement and subsidence met with in practice, as well as in the gradual consolidation of clap deposits.

The physical causes of this phenomenon have already been explained: The load produces a hydrostatic stress within the clay, which stress in turn causes the water in the clay to flow toward the surface, until stress equilibrium is reached, when the hydrostatic stress has decreased to zero. Basing calculations on this set of conditions, and on what has been developed in the preceding article on permeability, we can derive the relation between pressure, moisture content and time. That is to say, we obtain a solution of the time-settlement problem.

In Fig. 1 the pressure-moisture and moisture-permeability curves for a particular clay are given, as obtained by experiment. Suppose that a layer of this clay is enclosed in a rigid ring, and a load of intensity p_o per unit of area is applied to its upper surface, which is covered with water and is protected by a sand filter. What change will the layer undergo if the pressure is suddenly increased to p_1 and then kept constant?

According to the diagram, the moisture equivalent of pressure p_o is e_o, and the coefficient of permeability at moisture content e_o is k_o. When the pressure is increased these quantities ought to change to the values c_1 and k_1. But as the increased compression involves the escape of capillary water it is a rather slow process, and in every stage of this process the distribution of the hydrodynamic stresses must provide for the hydraulic gradient required to drive the capillary water out. This fact represents the point of departure for the subsequent considerations.

The diagram Fig. 2 represents a cross-section through the layer; h is the thickness the layer would have if its volume of voids were reduced to zero (reduced thickness). The origin of co-ordinates is taken at the lower surface of the layer and abscissa zero represents pressure p_o. At the upper surface of the layer the pressure is constant and equal to P_1, and the hydrodynamic stress is zero. According to the physical facts as set forth in the curves of Fig. 1, no change of water content is possible without change of pressure in the solid skeleton of the clay. But as we observe that the water content of the layer decreases while the external load remains constant, we are obliged to conclude that the pressure acting within the solid skeleton gradually increases. Let dp be the increase of the pressure p per time element dt, at height z above the base of the layer. The sum of the pressure p, within the solid skeleton and the hydrostatic pressure w at the same point must be equal to p_1, or $p_1 = p + w$. Differentiating, $dp = -dw$.

To determine how the pressure changes with time, assume a straight-line relation between pressure change and the corresponding moisture or void-ratio change. This assumption is permissible so long as the total change from p_o to p_1 is not large. The relation is expressed by the slope a of the pressure-moisture curve in Fig. 1. Then $de = -a\,dp = a\,dw$. The quantity of water which drains per unit of time through unit area of a horizontal cross-section at height z above the base is $Q = ks$, where k is the coefficient of permeability and s is the hydraulic gradient, equal to $-dw/dz$). Hence $Q = -k\,dw/dz$. But the hydraulic pressure w changes also with the time; i.e., while the water flows from elevation z to elevation $z + dz$, in the time element dt, the clay pressure p increases by dp, which equals $-dw$, and this change of the pressure involves a change of the water content according to the relation $de = -adp$, given above. Hence the quantity Q increases on its way from elevation z to $z + dz$, and we have,

$$\frac{dQ}{dz} = -\frac{de}{dt} = a\frac{dp}{dt} = -a\frac{dw}{dt}$$

Inserting the value of Q from the previous expression we obtain,

$$\frac{k}{a}\frac{d^2w}{dz^2} = \frac{dw}{dt}$$

This equation represents the distribution of hydrodynamic stresses in the clay. It is mathematically identical with the equation for linear flow of heat through a plate of isotropic material of thickness $2h$ and of uniform temperature, insulated on its lateral faces, which is transferred suddenly into a space of lower temperature. The rate at which cooling proceeds from upper and lower faces toward the interior corresponds to the progress of consolidation of the clay from its upper (loaded) surface downward into its interior. This thermodynamic analogy makes it possible to transform any time-settlement problem into a thermodynamic one, noting that heat content replaces moisture content e, specific heat replaces modulus of compression a, temperature replaces hydrodynamic stress w, and coefficient of heat conductivity replaces coefficient of permeability k. There are the further relationships that (1) in thermodynamics specific heat decreases with increasing heat content, and in the hydraulics of clays the modulus of compression decreases with increasing moisture content; (2) loss of heat causes a body to contract, and loss of water causes clay to shrink.

Similar analogies play a very important part in modern applied mechanics. Thus, there is a thermodynamic analogy for the flow of water towards a series of wells, and a hydrodynamic analogy for the torsional stresses in solid bodies. Another analogy is utilized in the soap film method of solving stress problems, recently proposed by A. A. Griffith. According to this method, one can determine the distribution of torsional stresses

over the cross-section of a twisted bar by simply measuring the deflection of a soap film stretched across an opening whose outlines are identical with those of the section.

The partial differential equation covers the whole field of time-settlement problems for watersoaked clay soils, and the special character of the problem merely influences the mathematical method to be employed for solving the equation. In dealing with the problem of gradual consolidation of a layer of clay under uniform load, at lateral confinement, the equation was solved by means of Fourier's series. From the results, numerical values have been computed, based on the following assumptions: thickness of the layer, 20 m., reduced thickness of the layer = 13 m., initial pressure 4 kg./cm.^{2}, final pressure 5 kg./cm.^{2}, modulus of compression 0.00002 g^{-1} cm.^{2}, and coefficient of permeability 0.100 cm. year^{-1}. The values of the two latter constants (a and k) correspond to the properties of a fairly fat clay in a plastic state. The results of the computation are graphically represented in Fig. 3. The curves show how exceedingly slowly the compression proceeds from the surface of the layer toward the interior. This explains the gradual increase of the settlement of structures resting on the surface of strata of plastic clay. The dotted lines represent the results obtained by means of an approximate method, based on the assumption that the distribution of the stresses follows a straight-line law; they agree well with those of the accurate method.

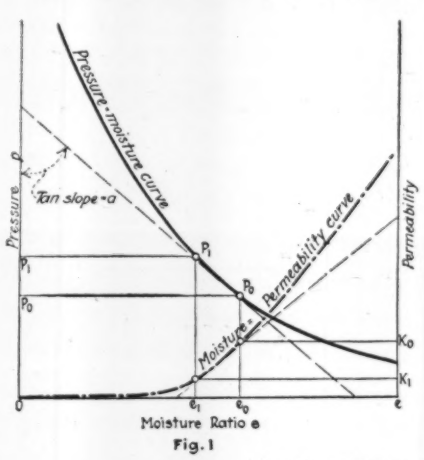


Fig. 1

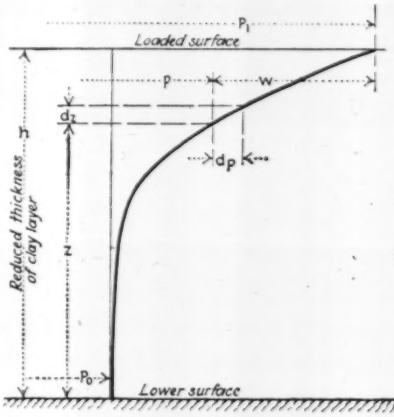


Fig. 2

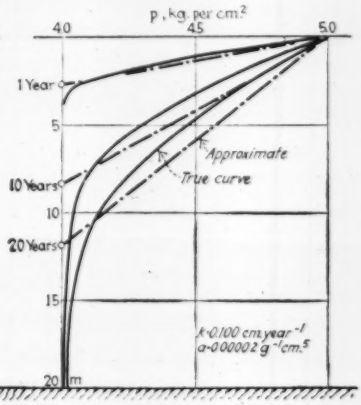


Fig. 3

FIGS. 1 TO 3—CONSOLIDATION OF A CLAY DEPOSIT UNDER LOAD
Fig. 1—Test curves for a clay sample. Fig. 2—Distribution of pressure through the layer.
Fig. 3—Pressure distribution after different periods

Some Applications

A few simple examples may indicate what information the theory of hydrodynamic stresses is able to furnish.

Natural Settlement of Mud Deposits — Suppose a basin (lake or bay) is fed by a muddy stream so that mud is deposited at a uniform rate per unit of area and per unit of time. After a certain time the process of sedimentation stops. We inquire what will be the distribution of the stresses in the deposit at any definite time, and what will be the annual rate of settlement of the surface of the deposit.

We must be careful to distinguish between the hydrodynamic stress w acting in the capillary water, and the static pressure p acting in the mud. The ratio $w : p$ decreases, as time passes, but the sum of these two pressures constantly equals the external load, which, in our case, is represented by the weight of the mud located above the cross-section for which p and w should be determined. For a shrinking clay cube the external pressure is equal to zero, hence the hydrodynamic stress w is negative and the pressure p (in this case called the capillary pressure), is equal to it and of opposite sign. The internal friction is equal to the product of the static pressure p times the coefficient of internal friction, while the hydrodynamic stress w cannot produce any internal friction. Hence a decrease of w at a constant external load produces not only an increase of p but a corresponding increase of the internal friction. These fundamental facts ought to become as familiar to the foundation engineer as Hooke's law to the structural engineer.

In Fig. 4, diagrams b and c represent graphically the results of the calculation for a mud deposit formed at the rate of 5 cu.cm. of solid matter per square centimeter of bottom area per year; b corresponds to a sandy mud and c to a mud with a high percentage of colloids. The dotted lines passing through the upper corners of the graphs b and c represent the stress distribution for hydrostatic equilibrium, reached after infinite time. The full lines divide the abscissas of the dotted lines into two unequal parts, the right-hand part corresponding to the hydrodynamic stress and the left-hand part to the static pressure. At the lower end of each full line (pressure-distribution line) is written the time which elapsed between beginning of sedimentation and state represented by pressure distribution.

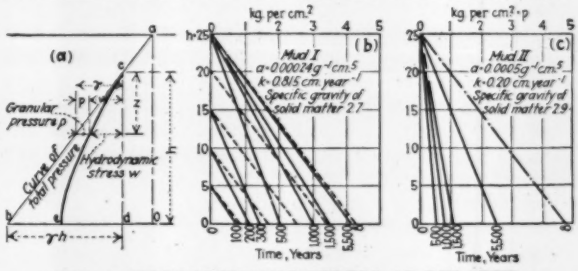


FIG. 4—HYDRODYNAMIC STRESS AS RELATED TO AGE OF DEPOSIT

From the diagram *c* in Fig. 4 (mud rich in colloids) it may be seen that 5,000 years after the deposit was formed the hydrodynamic stresses still amount to about one-half of the pressure exerted by the dead weight of the deposit. This fact indicates in turn that the internal friction of the mud amounts to only one quarter of what it will be after the state of hydraulic equilibrium has been reached. As the deposit represented by *b* is more permeable and less compressible than the deposit *c*, it is at that time (5,000 years after it was formed) almost in hydrostatic equilibrium.

A short time ago I had an opportunity to examine fresh samples extracted out of a young and very colloidal mud deposit by means of test borings. The tests clearly evidenced that the pressure corresponding to both the moisture content and the internal friction of the mud amounted to a small fraction only of what

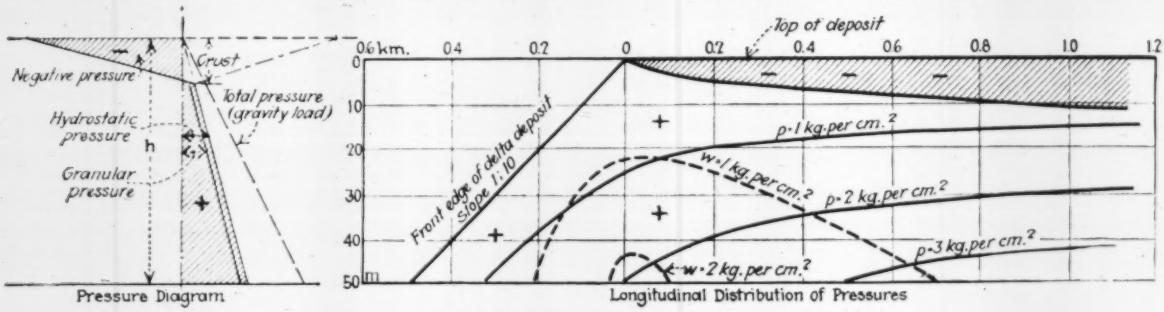


FIG. 5—STRESS DISTRIBUTION IN A DELTA DEPOSIT
Drainage by gravity and by evaporation. Negative hydro-dynamic pressures indicated by minus signs.

would correspond to the state of hydrostatic equilibrium. On account of the excessive hydrodynamic stresses, the bearing capacity of the deposit was so small that the plan of loading its surface with factory buildings had to be abandoned. After a few thousand years more, the same deposit would undoubtedly present a fairly good foundation.

Impervious and Porous Layers—Suppose, now, that the deposit just discussed, instead of being homogeneous, included a mud layer less permeable than the remainder of the material. Such a layer has precisely the same effect on the drainage process as a layer of poor heat conductor would have on the cooling of a deep stratum of hot substance. Above the layer the mud will drain more rapidly, while below the layer it will remain almost liquid for a long time, and there will be a considerable difference of hydrodynamic stress between the two sides of the intermediate layer. If, on the other hand, the deposit contained a sand layer instead of the colloidal layer, the hydrodynamic stresses above and below the layer would be equal or nearly so. A hole drilled down to the sand layer would furnish artesian water, and drainage would proceed more rapidly than before, with correspondingly accelerated settlement.

On two occasions I had an opportunity to observe such a phenomenon in practice. In the first case the mud deposit had a thickness of about 15 m. Immediately after the sand stratum was opened up by means of a caisson well, some buildings located in the vicinity of the well started to settle badly. During the first year following the construction of the well, the settlements amounted to several inches and their rate of increase decreased from year to year, as theory demands. The well furnished artesian water. In the other case the mud deposit had a thickness of 50 m. While drilling a test hole through the mud we struck a layer of sand at a depth of about 15 m. To the surprise of the drill men, we got a rush of artesian water into the casing, although no artesian conditions were known to exist in the vicinity of the site.

Evaporation from Mud Deposits—Deposits of soft mud whose surface is exposed to the air gradually dry out. Experience shows that this drainage by evaporation leads to the formation of a semi-solid or solid crust, whose thickness increases as time goes on. I have previously proved that the solidification of a shrinking clay is caused by the capillary pressure, which in turn is associated with a negative hydrodynamic stress of equal intensity.

Consideration of the physics of the evaporation process leads to the conclusion that during the drying process two successive stages must be distinguished, the first stage lasting from the beginning of evaporation to the time when the capillary pressure at the upper surface of the deposit reaches the value of the transition pressure. At equal speed of evaporation and equal value of transition pressure, the thickness of the crust increases during the first stage in direct proportion to the permeability of the material. If the materials of two deposits are identical, the thickness of the crust at the outset of the second stage will be in inverse proportion to the speed of evaporation. During the second stage the rate of increase of the thickness of the crust becomes exceedingly small and, in opposition to what is true for the first stage, almost independent of the temperature of the atmosphere.

Basing my computations on the results graphically represented in diagram *b* of Fig. 4, and on the deductions just stated, I surveyed the stress distribution existing in a delta deposit whose outer edge advances toward the ocean at the rate of 1 m. per year and whose capillary water evaporates along the horizontal top surface of the deposit. The outcome of the investigation is represented graphically in Fig. 5. The hydrostatic pressure within the capillary water of the crust is negative, that below the crust positive. The moisture content of the deposit just below the crust must be a maximum. If a canal is dug in the deposit to a greater depth its bottom will discharge water, while those parts of the slopes which are located within the crust will absorb water.

The positive hydrostatic pressure in the capillary water of the core of the mud deposit is the greater, the more rapidly the deposit was formed and the less permeable the deposit is. Due to the assistance of this excess pressure, natural deposits of highly colloidal mud are apt to flow out spontaneously, apparently without any

external cause. Such phenomena have been observed and they are known as "submarine landslides."

Conditions similar to those represented in Fig. 5 exist in hydraulic fill dams, for some time after they have been deposited. The less permeable the core material, the more important are the hydrostatic pressures in the capillary water of the core and the more imminent is the danger of a dam failure by lateral eruption of the core material.

Indirect Determination of Permeability of Clays—The theory of hydrodynamic stresses led to a very simple method for determining the coefficient of permeability of plastic or semi-solid clays. Suppose a layer of clay enclosed within a rigid ring and its surface covered with water is in hydrostatic equilibrium. If a surcharge is applied to its upper surface, there results in the capillary water a positive hydrostatic pressure whose intensity increases from the upper surface towards the bottom, while the simultaneous static pressure within the solid skeleton of the mass decreases from the top towards the bottom. If the load is kept constant, water will slowly be squeezed out. But if, instead of keeping the load constant, we keep the compression constant, by fixing the head of the testing machine in its new position, the moisture content of the layer can not change. Immediately after the head of the testing machine has assumed its new position, the hydrostatic pressure will be a maximuum near the bottom and a minimum near the top surface of the sample. As a consequence the water will move in an upward direction, causing the top part to swell, and the pressure acting against the head of the machine will decrease. Since the speed of the decrease of the pressure depends on the coefficient of permeability of the clay, the value of k can be calculated from rate of decrease of pressure.

Tests involving this action were made with an apparatus similar to that used for making load tests on saturated clay in confined condition. It consists of a zinc vessel, two bronze rings and a sand filter. The clay sample had a diameter of 8 cm. and a thickness of 4 cm. Pressure was applied by a screw testing machine. Fig. 6 gives the results. First a pressure of 14.1 kg./cm.^{2} was applied and then the head of the machine was held fixed. During the following hours the pressure decreased and gradually approached the value 1.72 kg./cm.^{2} (curve I). At the same time the rate of decrease of the pressure became slower, approaching zero. Let h be the reduced thickness of the layer, e_1 the moisture content, a_1 the modulus of compression (derived from the main branch of the pressure-moisture curve), a_2 the modulus of expansion (derived from the resaturation line of the pressure-moisture diagram), and k_1 the coefficient of permeability, all taken at the pressure p_1, and c_v a coefficient whose value can be calculated from the speed with which the pressure acting against the head of the testing machine decreases; then

$$k_1 = c_v \frac{a_1 h^2 (1 + e_1)}{2\left(1 + \sqrt{\frac{a_1}{a_2}}\right)^2}$$

Two days after the test was started, the pressure was raised from 1.72 kg./cm.^{2} to 27.3 kg./cm.^{2}, and the machine again held fixed. For this second stage of the test, the relation between pressure and time is represented by curve II. Similarly curves III and IV were derived, for still higher pressures.

By means of these tests it was possible to investigate with accuracy the flow of water through clays compressed by a pressure so high that their coefficient of permeability amounted to not more than 0.000,000,007 cm./min. Hence the sensibility of the method is practically unlimited.

The results of these tests proved conclusively that the flow of water through clays even of semi-solid consistency follows Darcy's law as closely as does the flow of water through sands.

Value of the Theory—Suppose an engineer observes that a structure founded on a bed of clay has suffered important settlements, and that the settlements increase in course of time at a definite rate; he publishes his observations and adds according to traditional practice some data concerning color and moisture content of the clay. A few years later another engineer wants to find

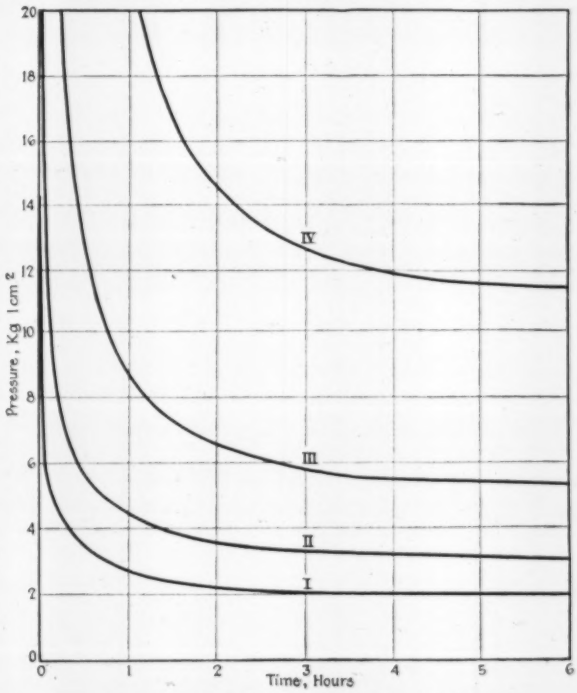


FIG. 6—PRESSURE-TIME CURVES FOR LOADED CLAY LAYER

At constant moisture content. The four curves represent different initial applied pressures. In each of the four tests the deformation was maintained constant after the load had been applied.

out whether a clay stratum at some other place will behave under load in a similar way. He will discover that he cannot. Or, if he is innocent enough to believe he can, with no other basis for conclusions than the data published by his predecessor, he will probably have later opportunity to revise his optimistic ideas.

But with the theory of hydrodynamic stresses at our disposal to explain the time settlement phenomena on a physical basis we are better equipped. The fundamental differential equation does not involve color or moisture content of the clay, but reveals the fact that the quantitative side of the time-settlement process depends only on the ratio a/k; everything else is non-essential for this particular process. Two clays may behave altogether differently in spite of their having the same blue color and the same moisture content, while two other clays of different color and different moisture contents may behave identically provided their a/k ratios are identical.

In order to compare two clays as to settlement, we must submit a sample of each to a test of such kind that the outcome of the test depends on nothing but the value of a/k of the clay. Several test arrangements are possible which satisfy this condition and, as a matter of course, we will adopt that one for which our laboratory equipment is best fitted. By comparing the results of the tests made with the two clays, we are in a position to foretell with a fair degree of accuracy how similarly or how differently the two clays will behave as to the relation between time and settlement.

The time-settlement relation, however, is only one of the many facts which may interest the earthwork-engineer. If he wants to investigate the tendency of clays to slide or the quality of core materials for hydraulic-fill dams he must execute other tests. These other tests must be planned according to the physical theory of earth slides and of the stability of dams, and with appropriate consideration of the constants which are essential to the processes in question.

No theory is required for *making* the tests. But on the other hand it is not probable that the tests will be properly planned unless the theory of the action is understood. That is the reason why the author felt obliged to start with the causative relations between the elementary facts of soil mechanics and the general laws of physics. However, the mental inertia which besets work in this field seems to be enormous, and it will still be a long time before engineers generally will see more clearly in that respect. Though more and more time and money are being spent in experimenting in the field of soil mechanics, few experimenters yet realize the fundamental difference between basing the analysis of test results on vague traditional concepts such as "internal friction" of sands or "cohesion" of clays, on the one hand, and on the other hand rigorously tracing the observed phenomena back to their physical sources —pure surface friction, structural factors, surface tension of the capillary water, and hydrodynamic stress.

Fabricating Cost of High-Strength Steel

IN CONNECTION with the extending use of high-strength structural steel in Germany during the past two years (see *Engineering News-Record*, Feb. 12, 1925, p. 273), studies to determine the excess fabricating cost of this material were recently carried out by a fabricators' association (Deutsche Eisenbau Verband) in co-operation with the German Railway Co. The results are reported in *Der Bauingenieur* of Sept. 18. The studies covered each one of the separate operations involved in fabrication, and were carried on in six different fabricating shops. Steel from three different mills was represented. Observations were made of working time, power consumption, tool wear, and other factors bearing on the question. The general conclusion is drawn that as compared with ordinary soft structural steel (54,000 to 64,000 lb. ultimate) the extra shop cost of the high-strength steel (68,000 to 82,500 ultimate) is 15 to 20 per cent, this amount including also the extra cost of storage and handling due to the necessity of keeping it separate from the other in order to avoid confusion.

Some of the individual observations may be noted as follows:

Specimens of the soft structural steel going through the shops during the studies ranged in ultimate strength from 58,000 to 64,000 lb. per sq.in., in yield point from 35,500 to 41,000, and in elongation from 24 to 30 per cent. The high-strength steel showed 71,000 to 82,000 ultimate, 43,000 to 49,000 yield-point, and 19 to 26 per cent elongation.

Storage and Handling—To avoid mistakes in using the high-strength steel must be sent in separate shipments, stored separately, and carefully marked (even short pieces left over when part of a bar is used should be marked), and must be followed carefully through the shop, with special care to maintain separate stocks of rivets. The extra cost of these precautions is 10 to 15 per cent.

Shearing—Shearing plates up to $\frac{3}{4}$ in. thick showed no marked difference between the two materials in maximum current or power consumption, working time or blade wear.

Planing—Planing 20-ft. lengths of $\frac{1}{2}$- and 1-in. steel showed somewhat increased power consumption over soft steel, but no decided difference in wear of tools.

Milling—High-strength steel showed distinctly higher maximum current and greater working time in milling, and apparently somewhat greater tool wear.

Sawing—Rapid dulling of saws is reported with high-strength steel.

Punching—Punching $\frac{1}{2}$-in. holes in $\frac{3}{8}$-in. steel and $\frac{7}{8}$-in. holes in $\frac{1}{2}$-in. steel showed no perceptible differences in power, tool wear, or quality of work between high-strength and soft steel.

Drilling—Drill breakages were greater for the hard than the soft steel.

Reaming—Sets of four $\frac{3}{8}$-in. plates were assembled, and $\frac{13}{16}$-in. holes were reamed to $\frac{7}{8}$, the holes being offset up to $\frac{1}{16}$ in. or more. Fixed and portable electric drills and air drills were used to operate the reamers. No difference was found in power consumption, but reaming was somewhat slower in the hard steel.

Riveting—Driving rivets of high-strength steel required somewhat more time. The necessity of maintaining separate rivet bins and keeping the hard rivets separate from the others in heating is also an item of extra cost.

Slight differences only were noticed in friction sawing and in hot bending.

The general observation that in most of the operations there was increased tool wear with the harder steel is checked by shop experience in fabricating a number of bridges during a period of several months, which indicated quite noticeable increase of tool wear (and probably also machine depreciation) with the harder high-strength steel than with ordinary structural steel.

As noted above, the observation in the aggregate are held to justify the conclusion that the cost of fabricating high-strength steel will range 15 to 20 per cent higher than that of fabricating soft steel.

Wide Vehicles Kept Off of Victoria Bridge

In order to speed up traffic movements and to prevent injury to other vehicles, all vehicles exceeding 6 ft. 6 in. in width or carrying loads exceeding that width are to be debarred from the narrow vehicular roadway of the Victoria bridge at Montreal except between the hours of 11:30 p.m. and 6 a.m. The roadway is so narrow that wide vehicles interfere with the traffic and frequently cause damage to other vehicles.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

TRINITY CHURCH, PORTSMOUTH, VA.

Portsmouth, Va.

COUNTY SEAT OF NORFOLK COUNTY. Portsmouth is situated on the Elizabeth River, opposite Norfolk, and the two cities join in some phases of municipal work; they have a common custom house. They have a fine harbor and fine transportation facilities, being connected with the Albemarle and Chesapeake ship lines and the Dismal Swamp canals. In Portsmouth are the United States navy yard, which has three large dry-docks and a plant for the construction of steel vessels, the naval training station and naval magazine, and the United States Naval Hospital. The city's industries are cotton mills, cottonseed-oil mills, lumber mills, knitting mills, hosiery and dye works, smelting works, and there are extensive oyster, fish and crab interests. The Seaboard Air Line's railroad shops are located in Portsmouth. Settled 1752; chartered 1858. Pop. (1920) 55,000.

PORTSMOUTH, VA., is a city laboring under a heavy physical handicap, which has had a decided effect on its engineering development. The disadvantage lies in the fact that the land upon which Portsmouth is built is so flat that water, sewer and street improvements become extraordinarily expensive. The difficulty which faces the engineering administration of the city is, then, considerable.

Portsmouth is a council-manager city. The city manager—the present incumbent being Gen. J. P. Jervey, an army engineer who retired after distinguished service with the American Expeditionary Force—is appointed by a council of seven members. In turn the city manager appoints the city engineer. All of the engineering work except that which is concerned with water supply is under the city engineer's direction. This concerns principally, however, the design, construction and maintenance of highways and sewers. The present city engineer is Joseph F. Weaver, Jr., who has practically grown up in the Portsmouth engineering office. To aid him, he has an assistant engineer, an instrumentman and one rodman as year-round employees; other field and office forces are acquired as construction or design demands. All money for public improvements is appropriated either from the general fund, a special fund for salary and administration, or special bond issues for particular municipal improvement projects.

Portsmouth has a population of approximately 55,000. It lies on the Elizabeth River at the entrance of that river into Chesapeake Bay. With various government and commercial deep water terminals and yards close at hand, and in fact with the U. S. Navy Yard practically within its own city limits, it would appear that Portsmouth would draw numerous shipping and manufacturing industries which would furnish no small part of the city's tax money. However, money for public improvements is difficult to secure, and as all work is expensive, the city suffers. Paving is very expensive because all materials have to be imported. The city within its six square miles of area contains 110 miles of streets of which 45 miles are paved. Asphalt types predominate, mostly due to the greater expense of the importation of competing paving material.

The street layout of Portsmouth is interesting viewed in the light of the rapid development in the use of motor vehicles. The principal traffic arteries are Elm Ave., a north-south thoroughfare, and High St., which runs east and west. Elm Avenue is 100 ft. between building lines with a 30-ft. width between curbs, the remaining width being parking strips and sidewalks. High St. is also 100 ft. wide but is 60 ft. between curbs. These two streets relieve to a great extent congestion that often is noted in the city of narrow streets. Congestion is further avoided by the unique fashion in which the town was originally laid out. Starting from the ferry and traveling westerly through the business section, alternate streets are 100 ft. and 60 ft. wide in the old part of the city, and traveling north or south through the business section, alternate streets are 32 ft. and 60 ft. wide in the old part of the city. This layout was made because the streets that are 32 ft. wide between building lines were first used as alleys. Traffic, the density of which could not, almost a century ago, be at all foreseen, has made it necessary to pave the alleys and use them as public streets. The advantages of this ample though unwitting provision for heavy traffic, are obvious.

Influence of Flat Topography—The average elevation of the city above tidewater is 10 ft. There is scarcely that much additional rise in elevation anywhere in the city. The tidal variation is 2.8 ft. Street and sewer work, therefore, becomes the chief engineering problem.

Because of the flat nature of the city, flat street grades prevail. Consequently, some difficulty has been experienced in ridding the streets of storm water. New street construction and repaving have therefore taken this problem into account and the general practice now is to drain water away from street intersections and into storm drains located in the middle of the long blocks. In effect this makes the streets concave between intersections though that concavity is but slightly noticeable because the flattest grades that will carry the storm water have been used. Such betterments can go forward, however, only at a slow pace because of the small amount of money made available each year for new pavement construction.

Portsmouth has a considerable mileage of paved streets traversed by street railways, on which the railway company has not kept pace with paving reconstruction done by the city. It has, however, continued to operate its cars over most of the original trackage, only very short sections having been abandoned. One may ride along numerous streets that are paved, though the railway in the street center still runs over an unimproved dirt roadbed. One is even confronted with the spectacle of riding over a new graded and paved street in the center of which rises at least 2½ ft. above the

pavement grade, the ungraded, unimproved street railway roadbed. It is obvious how greater the expense will be to bring the entire street section to its proper crown when such conditions prevail than it would be to make all the improvements at one time.

The city began in June of this year the construction of about 32 miles of sewer to serve approximately two square miles or about one-third of the city's area. The project is expected to take about 18 months to complete and will cost in the neighborhood of $300,000. The pumping system of sewage disposal in effect at New Orleans has been followed. George G. Earl, the engineer responsible for the New Orleans pumping system, was consulted on certain phases of the design. The sewage is to be carried by gravity on an average gradient of 0.3 per cent into five suction wells located at points of lowest elevation. From these the sewage will be pumped through a 36-in. line into the Elizabeth River just beyond the harbor bulkhead. Sewage is to be collected first in collecting manholes of an inside diameter of 5 ft. and an average depth of about 13 ft. below street grade. The walls of these collecting manholes are to be hard burned brick 8 in. thick, faces to be plastered with portland cement mortar half an inch thick. From these collecting manholes iron pipe is run to the suction wells. The bottoms of the suction wells are at an elevation of —17. This gives an extreme difference in elevation between normal level of sewage in collecting manholes and in suction wells of about 15 ft. From the suction wells the sewage is drawn into the pump house and pumped out into the river. The capacity of the pump installed is 11,220 g.p.m. Cast-iron pipe is used for suction and discharge lines, and terra cotta for the gravity lines. Sewage pumping will be automatic.

Inasmuch as the city is so little in elevation above the tidewater, and because the character of the soil is sandy in the main, any sort of sub-surface installation cannot be carried down to any great depth without extensive sheetpiling being installed. Sheetpiling is usually necessary if a trench is to be dug deeper than 6 ft., and quite often at lesser depths.

The city has an adequate water supply which is taken from Lake Kilby near Suffolk about 20 miles distant. There are other lakes in the watershed which are kept in reserve. The supply is filtered and pumped through mains with a standpipe for pressure equalization.

Facing such conditions as herein pictured, the city engineer has no mean task. It is one to tax not only a pioneer ingenuity but a patience often tried by a population not greatly interested in its engineering structures or administration.

Success in Fire Prevention at Fresno, Calif.

Fresno, Calif., a city of 75,000, last year won the Thos. H. Ince trophy for fire-prevention work. The good record in Fresno is ascribed to a campaign of fire prevention which has been very vigorously conducted in the past three years. This began on the assumption that 90 per cent of the fires are preventable and widespread interest of the citizens was enlisted in keeping down the fire loss. Since 1922 there have been three reductions in fire-insurance premiums in Fresno, which have amounted to a saving in annual premiums of between $375,000 and $400,000. This saving has been effected by a fire-prevention campaign costing $32,000.

Engineering Work

Small Activated-Sludge Plant at Macclesfield, England

AN ACTIVATED-SLUDGE plant with a nominal capacity of 0.18 U. S. m.g.d. treating pre-settled sewage has been added to the sewage-works of Macclesfield, England, a place with a population of about 34,000 and a dry-weather sewage flow of 1.2 U. S. m.g.d. Special features of the new plant are the use of surface aeration by means of paddles ("Simplex system"), shutting off the sewage at night when the flow is small but continuing tank aeration for at least part of the low-flow night period, and use of storage battery accumulators to supply power, while the sewage flow is cut off. Excess sludge is disposed of on land. The new and old parts of these sewage-works were described in a paper read before a district meeting of the Association of Managers of Sewage-Works on May 23 by F. T. Hambleton, manager of the Macclesfield sewage-works (see London *Surveyor*, May 29, p. 521).

The first sewage-works for Macclesfield was built in 1896 and was designed for a population of 40,000. It included "precipitation tanks" (evidently Dortmund type chemical precipitation), small coke filters and about 60 acres of underdrained land for the reception of the clarified sewage.

In 1907 there were added a hand-raked screen, grit tanks in duplicate, more settling capacity, four percolating filters, each 120 ft. in diameter, and a one-acre secondary filter. Even then, Mr. Hambleton states, the works were sufficient to treat only half of the sewage flow, the remainder going to 40 acres of land which also had to receive a considerable amount of storm water after settlement. The remainder of the farm was used for sludge disposal by trenching. In 1911 two storm-water tanks were built.

The activated-sludge plant was put in operation Sept. 23, 1924. The changes in and enlargement of the old works included mechanical screens in duplicate driven by a 5-b.hp. electric motor to replace the hand-raked screen of 1907; four 99-ft. diameter, 6-ft. deep percolating filters, with Simplex distributors, the same type of distributors provided for the old percolating filters; three humus tanks with a total capacity of 0 18 U. S. m.g.d. and an electric-driven centrifugal pump to lift humus-tank sludge to the land disposal area. At the same time, some old septic tanks were altered to give better control and action.

Before the activated-sludge plant of 1924 was provided, small-scale activated-sludge experiments were made and also larger-scale tests, the latter by making use of an old Dortmund tank. When the first disused Dortmund tank was converted into an activated-sludge plant, there was used as a model one of the first activated-sludge tanks at Bury designed by Mr. Bolton. The intention then was to combine aeration and sedimentation in a single tank and also to treat raw sewage. It was found that with a sewage which changed so rapidly in character as that of Macclesfield direct treatment by the activated-sludge process was impracticable and that with a tank of so great a depth and capacity as the Dortmund, there was insufficient surface area to give efficient aeration. It was therefore decided to base

Of the Small City

the design on the treatment of settled effluent, but it was made possible to treat all sewage if desired and for a time after the activated-sludge process was put in use in September, 1924, raw sewage was treated. That, however, was soon given up.

The two old Dortmund tanks which were converted into activation tanks were each 25 ft. in diameter with a 29-ft. water depth. For a settling tank, there was built over an old sludge tank with a diameter of 20 ft. and a water depth of 25 ft. Sludge is returned from the settling tank to the aerating tank by a Simplex sludge lifter. Excess sludge can be passed direct to land or to the sludge well serving another part of the plant. The sludge from the activated-sludge plant is delivered through an 8-in. force main to 32 acres of recently acquired land.

A new power plant was provided for the activated-sludge plant, including two 27-b. hp. semi-Diesel oil engines, working two 15-kw. generators and a storage battery of 120 cells, giving 180 amp.hr. at 220 volts. This plant supplies power for three (grit chamber) dredges, for the aeration paddles, the sludge, humus and clean water pumps, farm machinery and also for lighting both the plant and the farm.

The entire improvements of 1924, including the activated-sludge plant, were carried out within the estimated cost of £20,200, but this does not include £5,000 paid for 32 acres of land taken for sludge disposal purposes. It should be noted, however, that 70 acres of land now included in the sewage disposal scheme have been rented to a tenant farmer. (The exact total area of land now held for sewage disposal purposes is not clear from the original paper.)

The sludge from the activated-sludge plant and also that from the humus tank and the ordinary sludge produced at the works are either run thinly over land and plowed in or else dried in lagoons and used as manure on the land. Farmers in the neighborhood are making inquiries as to how the sludge can be transported to their land.

The Macclesfield sewage is described by Mr. Hambleton as "very variable" in character, and on the average rather above medium strength, owing to manufacturing effluent, mainly from the textile trade." As illustrating this variability, Mr. Hambleton gives two sets of figures, all in parts per 100,000: Total solids, 64 and 332; suspended solids, 28 and 152; chlorine, 3 and 12; oxygen absorbed, 2.4 and 14 5; free ammonia, 1.5 and 5.06; organic ammonia, 0.36 and 5.84. The second sample carried in addition 205 parts of sulphur, calculated as sulphate.

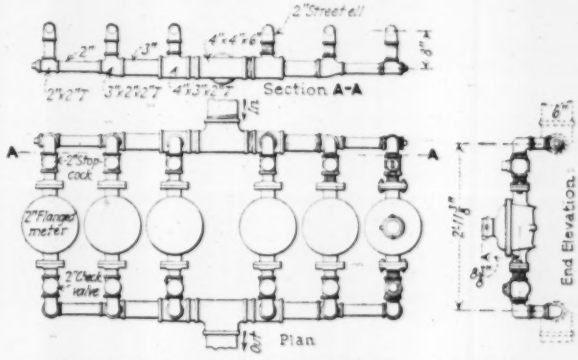
During the first three months of 1925, the plant treated an average of about 0.23 U. S. m.g.d. per 24 hr., but the actual time during which the sewage was flowing through the plant averaged only some 15 hr. a day, in addition to which there was an average of about 4 hr. a day of aeration of the sewage standing in the aeration tanks. The best results were obtained with a retention of some 7 to 10 per cent of the sludge.

The recent extensions were designed and constructed by J. H. Edmonson, then manager of the Macclesfield sewage-works but now occupying a similar position at Halifax.

Welded Headers Too Rigid for Meter Banks

IN THE distribution system of the Spring Valley Water Co. at San Francisco it has long been the custom to use banks of 2-in. meters instead of single meters of larger size. For example, on 3-in. lines, two 2-in. meters are used; on 4-in. lines, three 2-in. meters, and on 6-in. lines, six 2-in. meters. The method of connecting the meters, however, according to a report at the recent annual convention of the California section of the American Water Works Association, has been changed several times and only recently has a finally satisfactory method been adopted as standard. This standard is shown in the accompanying drawing.

For some time the plan was to terminate a 6-in. line, at the point where it was to be metered, in a 6x6x6-in. T on either side of which nipples were used for connecting three 6x6x2-in. T's. Into the 2-in. connections thus provided nipples and elbows were screwed as is done in the present standard. This plan was satisfactory but expensive and the expedient of welding 2-in. nipples into a 6-in. header was substituted.



SPRING VALLEY CONNECTIONS FOR BANK OF 2-IN. METERS

This welded job gave what seemed to be the same conditions for connecting up the meters but workmen complained that it was difficult to remove individual meters when testing or replacement became necessary. The fact was that the welded connection to the heavy 6-in. pipe made such a rigid construction that there was not enough spring or give to allow the meter flanges to separate so that a single meter could be taken out conveniently. With this construction, removing a meter took time and patience and even with skilful handling the gaskets were invariably destroyed.

Finally the scheme shown in the illustration was adopted and this is found to have the necessary flexibility without excessive cost. When a meter is to be removed the threaded joints allow the two T's involved to be turned enough to open the joint at the flanges and the meter can be easily taken out and replaced without loss of time or damage to the gaskets.

Water Meters Accurate After Long Service

The San José, Calif., water department recently made a wholesale conversion of meters on residence services from ¾- to ⅝-in. sizes, and in the course of the operation had occasion to test a large number of meters that had been in service for periods ranging up to 15 or 20 years. In a lot of 955 such meters tested in one month, whose average period of service was probably about seven or eight years, only three were found to be running fast.

Highway Officials Discuss National Roads Development

Broad Aspects of Public Roads, Federal Aid, Day-Labor Construction, Finance, Taxation, Traffic Control and a National Highway System, Discussed at Detroit Meeting of State Highway Officials

HIGHWAY development in its intersectional and national aspects and relations was the keynote of the deliberations of the American Association of State Highway Officials in convention last week at Detroit, Mich. About 230 delegates representing 46 state road departments took part in the committee work and in the general discussion of federal aid, day-labor road building, toll bridges, highway safety, road financing and taxation, research and intersectional and international relations. These subjects were in addition to the reports of committees through which the association carries on its technical studies and establishes its standard and recommended practices. There were fourteen reports of these committees covering specifications for and the design and construction of roads and structures, maintenance, tests and testing procedure, traffic and transport and contractual relations.

Day-Labor Construction—A plea for and a defense of day-labor road-building by the state opened the business of the convention. Alex. J. Groesbeck, Governor of Michigan, was the speaker. "It is my firm conviction," he stated, "put into practice, that in whatever a state undertakes in public works it must be the head of the enterprise." He then outlined the organization developed in Michigan for state construction of roads by which some 150 miles of paved roads have been constructed in the last two years by state forces employing largely prison labor. This construction, he asserted, averaged as high in quality and as low in cost as did similar road-building anywhere. The state, he said, was manufacturing its own cement successfully, had successfully replaced private ferries with state ferries, and was serving itself in all other matters of public road construction, wherever it chose, as well as or better than could private enterprise. "It is," he said, "an impossibility to build by contract a highway which will hold up and serve the public. If any state is to build highways it must not be subject to any combination of contractors or cement makers." In a future issue an account, based on a personal study, will be given of day-labor road-building in Michigan.

Federal Aid—Besides the formal resolution of the association, which is considered in a succeeding section, the case in support of continued federal aid in road-building was stated by F. F. Rogers, Highway Commissioner of Michigan, president of the association. Reviewing the history of road-building Mr. Rogers pointed out that always the practice had existed of the smaller units of government receiving aid from the larger units in their road-building tasks. The towns received help from the counties and in turn the counties were helped by the states. Therefore before the present federal aid law was passd in 1916, some 31 states were either aiding in the building or were actually building roads under the direction of fairly well organized state highway departments. The federal aid act was entirely in conformity with established political policies and it had had accomplished important things. In providing that the Bureau of Public Roads can deal with the states only through the officers of a properly organized state highway department, the law is responsible for the completion of such departments in at least 17 of the 48 states. The law is also responsible for the location of a system of interstate roads, some 200,000 miles in extent, so carefully co-ordinated at the state lines as to form a national highway system. "It is not a little disturbing," continued Mr. Rogers, "to the advocates of a perfected system of national highways to note the rising of a feeling against the continuance of federal aid for highway building just at a time when the work is highly organized, both in the federal department and in the states and when at least ten years more will be required to complete the system of roads so well begun."

Opposition to continued federal aid comes mostly from a group of states which claim they pay most of the federal taxes and could much better afford to build their own roads and not pay taxes for roads in other states. This immediately brought up the question as to what taxable unit is best fitted and most able to carry on the work and bear the cost of road-building in a manner that will best serve the needs of all the people. The smallest taxable unit that could be considered for this purpose was the township and 300 years of trying to get roads in this manner have been a complete failure. The next unit that could be considered was the county. While this was a long step in advance, the difficulty of connecting improved roads at the county lines and the lack of trained road-builders in most counties have fully demonstrated the failure of that unit. Later the states undertook the task for the most part with county aid and this was a much longer step in advance. It, however, is not in pace with changed conditions, said Mr. Rogers; the motor vehicle has become the principal means of transportation over the county highways. State lines have been obliterated and even federal courts have stepped in and said that the states shall not be allowed to place unreasonable regulations on the use of automobiles employed in interstate commerce (note the word) over the rural highways. The exact language of the court is, "A state has no power to fetter the right to carry on interstate commerce within its borders by the imposition of conditions or regulations which are unnecessary and pass beyond the bounds of what is reasonable and suitable for the proper exercise of its powers in the field that belongs to it."

Were it not for such a restriction, a poor state could so hedge itself about with drastic legal restrictions on road use that it would shut out cars from neighboring states. This being unthinkable, it is only fair and honest to hold the whole country as a road-building unit and tax it as a whole for aid in building interstate highways.

Interstate Highway System—The Joint Board of Interstate Highways, requested by the association at its 1924 convention and appointed in March, 1925, by the Secretary of Agriculture, announced the completion of its work through E. W. James, U. S. Bureau of Public Roads, as chairman. The report consisted of about a

hundred typed pages, illustrations and maps. Some 80,000 miles of roads were suggested by the states. This mileage was cut down to 75,884 miles or 2.65 per cent of the total mileage of public roads. The roads were numbered and a complete system of marking was adopted. All routes carrying east and west traffic were given even numbers, and all north and south routes were given odd numbers. Prefix numerals designate parallel sections, crossovers and cutoffs.

The report carries eleven recommendations covering the designation of selected routes as United States highways; the assignment of the numbering system; the use of a distinctive United States marker on all of the interstate routes, and a system of standardized directional and danger signs. The board also recommended that the Bureau of Public Roads be designated as a central agency to develop the system of standardized signs as other designs might become necessary, and the use of the signs on all roads under the jurisdiction of the several state highway departments was urged. The board also recommended that the cost of procuring and erecting the standard signs and markers on all federal-aid projects current, on such projects previously constructed and on all parts of the designated routes open and safe for travel be included in the construction estimates for federal-aid highways. This recommendation means that the United States government will share in the cost of purchasing and erecting the standard marker and signs. A recommendation was made that the Association of State Highway Officials undertake to secure suitable ornamental designs for an interstate marker and highway monument and it is probable that competitive designs will be asked for by the association. The recommendations conclude by urging that the use of any other distinctive markers on the highways except those required for administrative purposes by the several states shall be discouraged, and that all states shall secure through their legislatures, if necessary, the authority to designate, mark and post all routes under such jurisdiction.

Toll Bridges and Roads—Discussing the subject, "Are Toll Bridges and Toll Ferries Justified on a State Highway System," W. E. Atkinson, chairman, Louisiana State Highway Commission, said:

> Undoubtedly, bridges, ferries and roads built and maintained by the public, for which no specific charge is made for their use, are by far the more desirable, and wherever the public funds permit there should be no question as to the better system to adopt. When, however, the public must decide which is better: No road, no bridge, no ferry; or a toll road, toll bridge, toll ferry, there can be no question between the two propositions. It is infinitely preferable to have a toll road, toll bridge, toll ferry, than none at all. The road-building program in the United States has been so startling in its magnitude, requiring the expenditure of such vast sums of money, that it has been practically impossible to finance the building of necessary and essential roads. It has been found desirable, therefore, in many states to supplement the road system by awarding to private capital the privilege or franchise to build and operate toll bridges over certain streams, the toll being paid by those using the bridges. Thirty states have such bridges.
>
> I favor free roads and bridges, built, owned, maintained and operated by the public. But I am also in thorough accord with the spirit of our legislation which provides that when the highway commission finds itself financially unable to build and maintain these expensive structures, the commissioners are authorized to contract with private capital to build and operate toll bridges, under supervision of the governing authorities. To state the proposition tersely; I favor construction by private capital of toll bridges rather than to have no bridges at all.

Highway Financing—Two papers bearing on practice in highway financing were read by J. T. Donaghey, state highway engineer of Wisconsin, and Roy A. Klein, state highway engineer of Oregon. Speaking on the pay-as-you-go plan of highway financing, Mr. Donaghey presented estimates based on middle western states conditions showing: (1) that the sum, at the present rates of license fees and gasoline taxes was but a minor item of the total expenditure for motor vehicle ownership and operation; (2) that the operating savings realized from improved roads much more than paid the amount of fees and taxes; (3) that these fees and taxes as of present amounts provided annually for about as large a construction program as could be well handled in one year; and (4) that no allotment of fees and taxes could be considered just which did not provide some distribution of funds to counties and townships for local road upkeep and improvement.

Giving the history and statistics of gasoline tax development, Mr. Klein said:

> No preferences as to construction or maintenance, etc., should be placed on the expenditure of those funds, but all revenue should be placed in a common fund and the expenditure left to the judgment of those in charge of the highway program. It is necessary, however, as a matter of good faith with the motorist that the gasoline tax should be used for road purposes exclusively and not diverted to other departments of government.

Highway Research—One of the most important developments of the past year in highway research, stated Charles M. Upham, state highway engineer of North Carolina, has been the beginning of investigations on various problems which are financed by the industries concerned and are being conducted under the auspices of the Highway Research Board of the National Research Council. Studies now under way are:

1. Economic Value of Steel Reinforcement in Concrete Roads: This investigation covers actual field conditions in every section of the country and the final report to be presented at the annual meeting of the Highway Research Board in December will be the most complete study of reinforced-concrete roads ever undertaken.

2. Development of Earth Roads: The object of this investigation is to stimulate research to evolve some type of road surface that will be low in first cost and maintenance and suitable for light traffic.

3. Culvert Pipe Investigation: The object of this study is to determine by means of field inspections the proper basis of comparison for evaluating the life and economic value of different types of culverts and small drainage structures.

4. Investigation of Urban Highway Finance: The objects of this study are to determine the relation of the city dweller to rural highway finance and of the financial aspects of widening city streets and of city traffic control.

Other Papers—Other papers reserved for separate consideration in these columns are: Economics and Methods of Widening and Straightening Pavements, by William H. Connell, deputy secretary of highways and engineering executive, Pennsylvania Highway Department; Our International Relations as Shown by the Pan-American Road Conference at Buenos Aires, by Thomas H. MacDonald, chief, U. S. Bureau of Public Roads; and Highway Police and Highway Safety Devices, by John A. Macdonald, state highway commissioner of Connecticut.

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Safety in Construction Work

RULES of general application in construction work are given in the following extract from the report of the Committee on Reduction of Accidents to Employees, presented at the recent convention of the American Railway Bridge and Building Association:

Scaffolding should be erected and taken down only by experienced men. It should be strongly constructed. The lumber should be fir, spruce, or southern pine, or any suitable woods, avoiding the use of hemlock or other brash varieties. It should be straight-grained and free from large defects that would affect its strength. The parts should be secured by nails of sufficient size, driven to full length. The planking for the floors of scaffolds should be of uniform thickness and so placed that no step will cause any plank to overturn or tip. Guard rails and toe boards should be provided on all high scaffolds. The uprights should have a solid foundation secure against displacement, and all parts should be thoroughly braced.

Care should be taken not to overload scaffolds with men or materials. They should be kept clear of all rubbish and of such tools as are not in use. Nothing should be thrown from the scaffold. Material should not be dropped onto it nor should men jump on it. In winter, the scaffold and all working parts should be cleaned of ice and snow and sprinkled with sand or ashes before starting regular work. When working high, the men should learn to watch every step and always be secure against loss of balance. Those men who tend to become dizzy when working at heights should be used elsewhere, as they are a source of danger to themselves and others. All should realize the dangers from falling materials and tools.

Lifting jacks are in common use in bridge and building work, and certain elements of danger in their use must be guarded against. They should be of sufficient strength for the work. The jack should be properly centered under the load, using a piece of wood over the head of the jack when necessary to prevent slipping. Men must keep clear when the jack is released. Jacks should be set on a solid footing and braced if necessary to keep them plumb. Men should keep from under objects supported only by jacks, until horses or blocking of sufficient strength are in place. A jack should not be used if the pawl does not fully engage in the ratchet for the entire length, as either the load may drop all the way to cause possible injury or it may slip a few cogs and then engage, throwing up the lever.

Certain men may be found on the force who seem to habitually drop tools and material. This is especially dangerous when they are working above others and if they cannot mend their ways they should be placed in another kind of work or discharged. Even when not in use, some of the hand tools are a source of danger. They should always be kept in place so no one will trip over them or be cut by them, and so that they will not fall on anyone.

Care must be used in handling wrenches. One too large for the nut may slip. The wrench should face in the direction of turning. The teeth of pipe wrench jaws should be kept sharp. Wrenches should not be used as hammers.

Handling timber is the cause of numerous accidents among bridge and building men. Part of these accidents are due to improper tools or the improper use of tools. Cant hooks should be sharp and have the metal part well secured to the handle. In rolling timbers the men should preferably work from the end, so nothing will catch their legs. Men working with an adze should stand with their legs well spread and should grip the handle so firmly that they will not be hit if the blade catches on the edge.

In general the good workmen know the safe way of working with their tools. It is a duty to see that the newer men are trained in the safe way and that none relax from safe methods at any time, a tendency often due to haste.

Falling and slipping cause a great number of accidents, mostly due to the personal carelessness of the men. Here the foreman and supervisory officer can help by watching the men and cautioning them to be careful where they step. The men can make their workplace much safer by keeping it clean. Tools and unused materials should be kept out of the way. Men should be continually cautioned not to leave boards about from which nails are protruding. On bridge jobs where there is a high fill there is eventual economy in digging steps in the bank for the men or in constructing a good stairway with a railing. Runways for wheelbarrows should be sufficiently wide and well supported, so that there will be no danger of a man falling off should he momentarily change his balance with the load.

Many men are injured by falling and slipping while several are working together handling heavy material. When such material is being carried the foreman should caution the men to watch their step and to keep in step. Men should not be required to walk backward when there is danger of mis-stepping.

Concrete Siphons Under Highways Have Curved Wings and Elbows

THE frequency with which small irrigation ditches have to be taken across state highways led to the development by the Idaho State Bureau of Highways of an inverted siphon with curved sections designed for the minimum hydraulic loss and the least danger of choking. The one difficulty with the design was that the curves which were so essential to attaining these ends made the culverts hard for the contractors to handle satisfactorily. To meet this situation the state has designed and built a supply of steel forms which simplify construction and which can be rented to contractors doing state highway work. The curved design has now been in use for three years and experience includes several thousand installations. The design is being continued as very satisfactory.

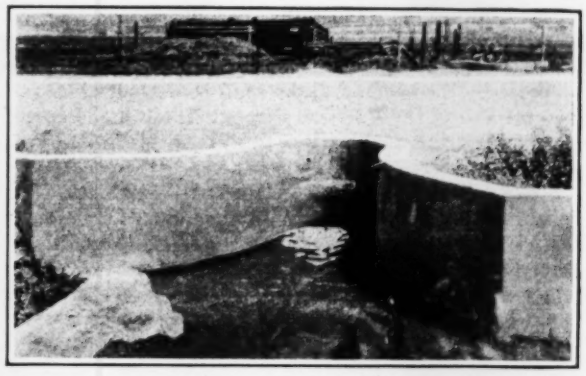


FIG. 1—MONOLITHIC SIPHON IN SERVICE

It was found desirable to standardize irrigation ditch crossings in four sizes with diameters of 18, 24, 30 and 36 in. Forms built in these sizes are rented to contractors for $25, $30, $35 and $40, respectively, this charge being for each set of forms for the duration of the contract. With the forms the contractor receives

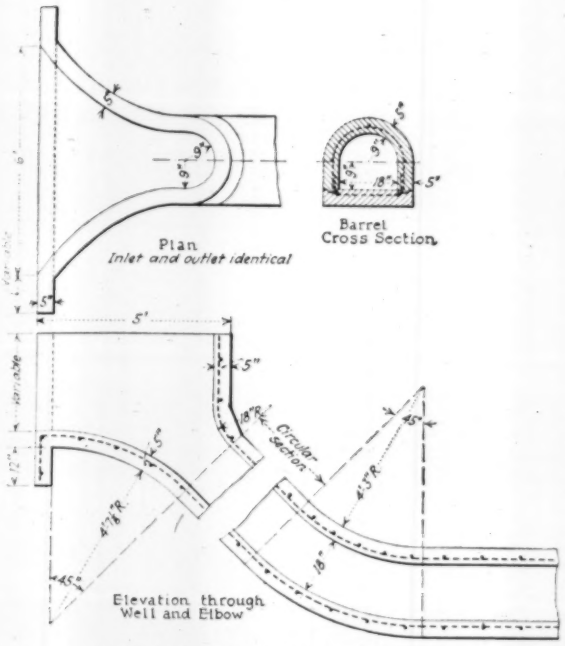


FIG. 2—DETAILS OF 18-IN. SIPHON

mimeographed instructions and blueprints showing how the setup is made.

The barrel of the siphon or the section under the roadway proper is built in two halves, and in each half the barrel is made in two pours—the invert being made first with a groove for bonding to the wall section, and the walls and arch being poured in the second operation. After the barrel is in place the well forms complete, consisting of wing-, circle- and elbow-forms, are set up to join with the barrel section.

The principal difficulty in forming the curved ends as at first attempted was in removing the forms after the concrete had set. The design worked out by the highway bureau therefore makes special provision for this. The well forms at the top can be removed easily enough, the chief difficulty being in getting forms out of the elbow without damage to forms or concrete. This was accomplished by building these forms in sections, *A*, *B*, *C*, *D*, etc., and chaining the sections together so that by pulling on the chain the sections are removed in the desired order. The surplus or slack in the chains between sections is held out of the way by means of wire hooks attached to the upper part of the forms and arranged to pull out easily. The forms are well oiled before each setup and have been found very durable.

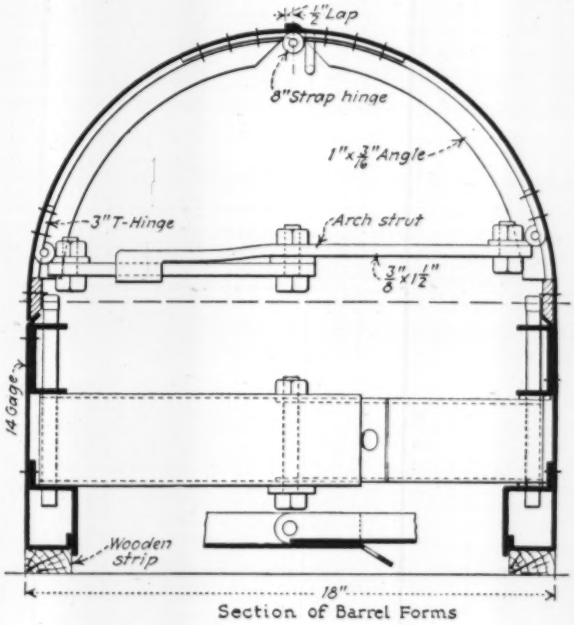


FIG. 3—FORMS USED IN SIPHON BARREL

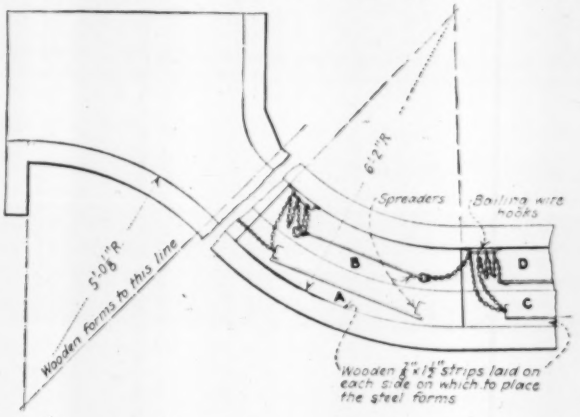


FIG. 4—ARRANGEMENT FOR CONVENIENT REMOVAL OF FORMS FROM ELBOW

The steel reinforcing used in the siphons ranges from 65 lb. per cu.yd. for the 18-in. size up to 95 lb. per cu.yd. for the 36-in. siphons. Concrete ranges from 0.106 cu.yd. to 0.190 cu.yd. per foot of barrel for the 18 to 36-in. range in diameter.

Design of these monolithic siphons was worked out by W. R. Heyde, state bureau of highways, Boise. Information used in the foregoing was supplied through the courtesy of Earl C. Evans, office engineer, Pocatello, Idaho.

Investigation of Water Duty on 200-Acre Suburban Tract

By E. P. Arneson
Irrigation and Highway Engineer, San Antonio, Texas

A RECENT drought has quickened an interest in irrigation at San Antonio, as elsewhere in Texas. Recently the writer undertook to determine for a group of irrigators the amount of water they had used within the period, August 1924 to July 1925 inclusive, an extremely dry period. The land upon which the investigation was made included eight farms, aggregating about 200 acres lying adjacent to the southwest city limits of San Antonio. The ground surface slopes 3 ft. per 1,000 ft. The water for irrigating is derived from an artesian well 8 in. in inside diameter and 1,045 ft. deep. This was completed in 1918, at which time the

water rose to within 9 ft. of the ground surface. A vertical centrifugal pump, set 30 ft. below ground, with a suction pipe extending 20 ft. lower, is driven by a 30-hp. induction motor.

In order to learn the amount of water pumped during the twelve months' period, it was, of course, necessary to know the hours that the pump was run and also its rate of discharge. The record that the irrigators kept proved to be very inaccurate and was rejected as of little value for a water duty investigation. The public service company's books, however, showed the kilowatt-hours consumed by this plant for every month. This record had been taken from meter readings and was accepted as accurate.

A 10-hr. test of the pump's discharge was made by measuring the flow of water over a sharp-crested weir. Readings of the head on the weir and readings of the watt-meter were taken every half hour. This test gave a direct relation between the pump's discharge per hour and the kilowatts consumed—1,100 g.p.m. and 22 kw.-hr. (29.5 hp.-hr.) respectively. This of course was the performance of the plant for the conditions in the well on the day of the test only, and could not be applied to other times of the year because of the fluctuations in the water level. A record of these fluctuations was found in the daily pump charts of the municipal water-works. It so happened that the above conditions were the same as those under which the pump was originally designed.

Inasmuch as the characteristics of the pump, that is, its discharge and power consumption under varying heads, were not available, advantage was taken of a table by Gardner S. Williams in the American Civil Engineers Pocketbook entitled "Average Performance of Centrifugal Pumps." Taking the design conditions of the pump as 45-ft. head, 1,100 g.p.m. discharge and a 29.5 hp.-hr. power consumption, the constants from this table were applied to the fluctuating heads during the months involved, with the results shown in the fifth and ninth columns of the accompanying table. Knowing then the power consumed for an hour's run of the pump in any month, the public service company's record gave, by simple division, the total hours for which the pump was operated during that month (column 11). From the latter figure followed the total water placed on the land during the same time.

The table shows that the total water used throughout the twelve months was 37 in. on the gross area of 200 acres. The maximum demand on the pumping plant was 5.79 in. of water over this area in 31 days. The rainfall distribution is shown in a parallel column and also the combined water from rain and irrigation is given in the last column. A striking but reasonable deduction from the last column is that during the most productive season of the calendar year the 200 acres required a fairly constant amount of water every month, whether it came from rain or from the well; this averaged 5.5 in. monthly.

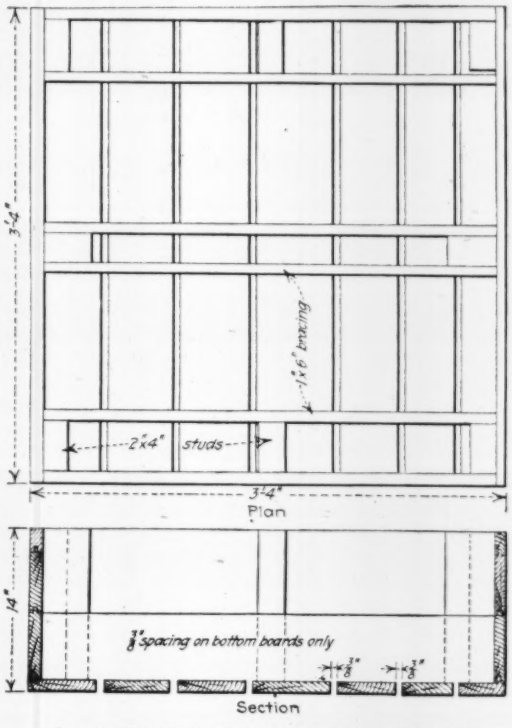
From Job and Office

Hints that Cut Cost and Time

Formwork for Drop Hammer Anvil Pocket

By Claude W. Wright
Meriden, Conn.

IN BUILDING a concrete foundation for a series of drop hammers extreme care had to be used in making the surface of the anvil pockets both smooth and level to receive the machined base of the anvil. Grouting to take out any irregularities in the surface was forbidden because it would not stand up under repeated



FORMWORK FOR DROP HAMMER ANVIL PIT

WATER DUTY STATISTICS IN IRRIGATING 200 ACRES OF LAND FROM AUGUST, 1924, TO AUGUST, 1925

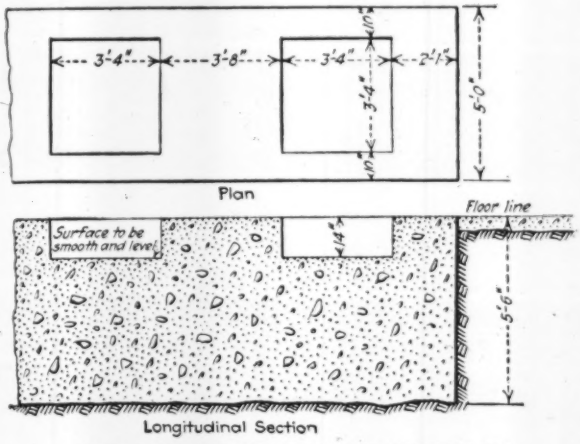
Year	Month	Head—Ft.	Head—Per Cent of Designed Head (45 Ft.)	Discharge—G.p.m.	Discharge—Per Cent of Designed Discharge (1100 G.p.m.)	Brake Horsepower—Hp.	Brake Horsepower—Per Cent of Designed Hp. (29.5)	Kw. per Hr.	Kw.-Hr. Used	Monthly Pump Service, Hr.	Water Pumped Acre-Ft.	Water Depth on 200 Acres In.	Rainfall	Total Water Used, In.
1924	Aug.	38	84	1,245	113.2	29.9	101.3	22.3	9,400	422	96.5	5.79	0.00	5.79
	Sept.	38	84	1,245	113.2	29.9	101.3	22.3	5,750	258	59.1	3.55	2.52	6.07
	Oct.	40	89	1,207	109.7	29.8	101.0	22.3	5,320	239	53.0	3.18	0.52	3.70
	Nov.	40	89	1,207	109.7	29.8	101.0	22.3	4,100	184	40.8	2.45	0.24	2.69
	Dec.	40	89	1,207	109.7	29.8	101.0	22.3	240	11	2.4	0.14	2.31	2.45
1925	Jan.	41	91	1,189	108.1	29.7	100.9	22.2	1,810	82	17.9	1.08	0.36	1.44
	Feb.	41	91	1,189	108.1	29.7	100.9	22.2	2,710	122	26.7	1.60	0.09	1.69
	Mar.	43	96	1,140	103.6	29.6	100.4	22.1	4,580	207	43.3	2.60	0.24	2.84
	Apr.	44	98	1,120	101.8	29.5	100.2	22.0	9,150	416	85.7	5.15	0.18	5.33
	May	44	98	1,120	101.8	29.5	100.2	22.0	3,910	178	36.7	2.20	2.85	5.05
	June	46	102	1,074	97.6	29.4	99.8	21.9	9,140	417	82.3	4.94	0.48	5.42
	July	46	102	1,074	97.6	29.4	99.8	21.9	8,000	365	71.9	4.32	1.24	5.56
Total									64,110	2,901	616.3	37.00	11.03	48.03

From Job and Office

For Contractor and Engineer

blows. Evenness of the surface was therefore secured by exercise of extreme care in framing the formwork.

The pockets are 3 ft. 4 in. square and 14 in. deep. Forms of such outside measurement were therefore constructed, as illustrated herewith, the vertical pieces being 2x4s and the bracing being 1x6 pieces. By spacing the bottom form boards about ⅜ in. and bracing the forms so as to prevent any spring under pressure of wet concrete, a true base was secured for the anvil.



CONCRETE FOUNDATION FOR PNEUMATIC DROP HAMMERS

The spaces between bottom form boards allow the escape of any air which otherwise might form pockets in the concrete. The concrete oozes up between the ⅜-in. cracks in the bottom form boards, but upon removal of the forms the fins thus formed are easily rubbed down to the main surface.

It is obvious that the complete form had to be placed level in the first instance and braced to prevent floating or other movement.

Job and Office Notes

Advantages of Crawler Mounting Over Railroad track mounting for shovels at the Bingham mine of the Utah Copper Co., are noted in a recent paper by H. C. Goodrich, chief engineer of the company. With eighteen shovels of the railroad type converted to crawler traction during the past two years, the indicated result is that output is increased about 10 per cent. Before the change the average amount loaded was 1,350 cu.yd. per shift, while since the change the average has been 1,500 cu.yd. In addition to the increased production per shovel, the crawler tractors decrease the operating cost of each shovel by the elimination of three pit men. The somewhat greater cost of maintaining the crawler tractors over the railroad traction is more than compensated by the elimination of the track work incidental to the latter.

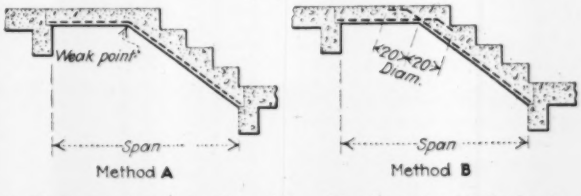
Prompt Emergency Work in the reconstruction of a railroad trestle destroyed by fire is described in the *Illinois Central R.R. Magazine.* An open-deck trestle 643 ft. long and 25 ft. high, over the Okaw River near Allenville, Ill., was discovered to be on fire when a train passed at 9:30 p.m. on June 10, but a bucket brigade of trainmen and passengers was unable to check the flames, while fire departments from two towns could not reach the scene in time and the structure was entirely destroyed. As soon as the division officers were informed they requisitioned materials from different points for prompt shipment. Several bridge gangs and section gangs were assembled, making a force of about 95 bridge men and 50 section men, so that the work could be carried on continuously by day and night shifts. By 10 a.m. on June 11 a railway pile driver was at work and a second machine arrived about 2 p.m. All material was unloaded at the south end, and teams hauled the timbers to convenient points for building the bents. All bents were framed and bolted, and were set in place on the piles by derrick cars. Engineers set line stakes and gave cutoff levels for the piles. The work was completed by 3 a.m., June 13, after 47 hours of work and only 54½ hours after the last train had passed.

Cutting Piling Under Water as described in *Engineering News-Record* October 8, 1925, p. 601, occasioned the following note from Arthur LaMotte, manager technical section, explosive department, E. I. Du Pont de Nemours & Co., Wilmington, Del.:

"In connection with your mention of the use of dynamite for this purpose, some very satisfactory work has been done by making a canvas sausage filled with dynamite. The dynamite cartridge is placed in the canvas and the canvas sewed around it. I think that those really interested in using dynamite for this purpose will find that this method of preparing the dynamite will be a little more satisfactory than trying to fill a piece of hose. Also for this work the straight dynamite should be specified as this type of dynamite has the quickest action in work of this kind and consequently will be the most effective. The 60 per cent strength is the best. This style of dynamite sausage has also been used to very good advantage for cutting up the steel hulls of wrecked vessels or other work of this kind under water."

Electrification of Suburban Lines on the Southern Ry., which is being completed and put into service gradually, has involved considerable alterations to the various London terminals on account of the increased service of trains. Cannon St. station is the principal city terminal of the Southern Ry., and this, built on the edge of the Thames and surrounded on other sides by business property, is presenting some serious problems to the Southern Ry. engineers. At the present time steam trains pass over certain switches on the bridge outside this station with only 15 seconds between them, and the present arrangement of tracks obviously would be unsuitable with a train service of three trains for every one now running. The engineers have realized that remodeling of the switches and tracks on the bridge approaching this station would be impossible, so it has been decided to redesign the entire layout. The station will be closed down a half at a time. The new junction has been planned and the completed trackage is to be laid down according to this plan on a piece of waste ground just outside London, where it will be subjected to every conceivable test. When it has proved satisfactory, the track will be taken up in sections, labeled and relaid at Cannon St. terminal.

In Reinforced Concrete Stairs spanning lengthwise, with a landing at the top as part of the span, steel is often placed as shown in method *A* in the illustration. The bars are placed in single lengths with a bend at the intersection of



the bottom of the landing slab with the rake of the stairs. Theoretically, this is questionable practice, suggests B. H. Wilson, Cincinnati, who offers an alternative design. When the slab supports a load, the steel takes axial tension, which tends to straighten it at the bend, at the same time causing a tendency in the concrete cover to crack off. By placing the steel with a full tension lap of about 40 diameters, as shown in method *B*, the stress is removed from the weak point.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Views on Soil Mechanics

Sir—In reading Dr. Terzaghi's article on "Soil Mechanics" in *Engineering News-Record* of Nov. 5, p. 742, one is somewhat startled to find the statement that severe tensile stresses can exist in the water which fills the capillary voids of unconfined clay. After a lifetime of reliance on the supposed axiom that water is incapable of sustaining tension, it is certainly surprising to read of an experiment in which a tensile stress of 4,800 lb. per sq.in. is required in the capillary water to account for the observed shrinkage of a specimen of blue marine clay.

An interesting example of the existence of severe stresses in connection with the shrinkage of clay was noted several years ago in the testing laboratory of the Miami Conservancy District at Dayton, Ohio. In the course of investigations on materials suitable for use in the cores of hydraulic-fill dams, many samples of clay were mixed with water to a rather thin consistency, placed in drinking tumblers of a heavy "restaurant" type, and stored for observation on the shelves of the laboratory. After a period of some weeks only an inch or so of dry clay remained in each tumbler. Many of the glass bottoms of the tumblers were cracked or shattered. The direction of the primary cracks appeared in most cases to be concentric with the outline of the base, as if caused by heavy pressure from below. Such pressure, if applied in any ordinary manner, would have to amount to hundreds of pounds before cracking could occur. How such a pressure could be developed by a few ounces of unconfined mud was a mystery.

It would seem that Dr. Terzaghi's studies have now furnished the key to the understanding of this phenomenon. The water in the voids of the clay is apparently capable of transmitting an upward or tensile force to the inside of the base of the tumbler, amounting to several thousand pounds per square inch. This would normally be exactly balanced by the downward compressive reaction of the clay particles, but as in the case of all granular materials in a cylindrical bin, a portion of this reaction is carried by arching to the side walls and to the outer portions of the base circle. The resultant net upward force on the central portion of the base is sufficient to rupture the glass.

Pittsburgh, Pa., Nov. 7, 1925. HAROLD A. THOMAS, Carnegie Institute of Technology.

Sir—The subject matter of the articles on Soil Mechanics, which appeared in your issues of Nov. 5 and 12, appeals strongly to the imagination but the arguments presented leave the mind adrift in a sea of wonder and amazement.

Because a clay mixture may be compressed under load the author ingeniously assumes that when clay shrinks an equivalent pressure is therefore brought to bear on its top surface through the agency of a force which he calls "capillary pressure" and which acts through "surface tension." This assumption is developed through devious phases and on page 800 is summarized as follows: "The cohesion of clay is due to two factors. One of these is the pressure exerted by the surface tension of the capillary water, a force whose intensity exceeds all the other forces the earthwork engineer has to deal with. It may amount to several hundred atmospheres." Again, on page 745, it is stated: "Thus the capillary pressure may be a force of enormous intensity. Yet the very existence of this force has never been suspected up to this time."

If, in the first of the above quotations, "several" means two, then this force is of the order of 3,000 lb. per square inch or 216 tons per square foot! A force of such intensity applied on the surface of a clay is a phenomenon well worthy of careful notice. If, in fact, this force is definite and tangible, and acts (p. 744) "all over the top surface of the clay," it should be susceptible of direct measurement. To postulate a force of this magnitude on the fragmentary evidence presented and the inconclusive argument advanced is a severe test for the native credulity of the uninitiated.

The writer of this letter is reasonably familiar with the most recent views regarding the phenomena of capillarity, of surface tension, of adsorption, and of the effects due to surface attractions, but has never found anything in those views to indicate that action and reaction are not always equal and opposite in direction. If this great and hitherto unsuspected force, acting to compress the clay, were shown to find its reaction in the atmosphere above the clay, then perhaps the proposition might be considered proven! But if, on the other hand, this force, through the agency of what the author assumes as a stress of tension, reacts within the clay, then if the effort were made to free a cubic inch of the material from its original position, the vertical force necessary to do so would exceed the clay weight by something more than 3,000 pounds!

Let it also be noted in Fig. 4 on p. 744 that, if the capillary tubes and their water content are in any state of tension whatever, then the tensile resistance of the clay must be greater than the capillary tension; greater than 3,000 lb. per square inch! The proof of such a proposition requires neither argument nor elaborate apparatus; so simple a device as the chimney of an old-time student lamp will serve every purpose. THADDEUS MERRIMAN, Chief Engineer, Board of Water Supply.

New York City, Nov. 18, 1925.

[Replying to Mr. Merriman's letter the author writes as follows.—EDITOR.]

Sir—Mr. Merriman's reaction on my papers, "Cohesion of Clays" and "Compressive Strength of Clay," is not surprising, inasmuch as the facts communicated in these papers certainly are apt to strike the unprepared mind.

Freed from the non-essential, Mr. Merriman's argument is this: The internal pressure in the clay is supposed to amount to 3,000 lb. per sq.in., hence the tensile strength of the clay ought to be 3,000 lb. per sq.in. This statement is theoretically correct. It is analogous to the following statement: According to the results of independent experiments, the internal pressure of iron—which means the force with which the iron particles are pulled together by molecular forces and cohere to each other—amounts to 4,000,000 lb. per sq.in., hence the tensile strength of iron ought to be equal to 4,000,000 lb. per sq.in. The proof of this proposition, too, requires neither argument nor elaborate apparatus, not even the old-time student lamp; yet the tensile strength of iron is not more than about 57,000 lb. per sq.in. or equal to about 1.4 per cent of the internal pressure. So far as metals are concerned, the cause of this apparent contradiction has been studied, chiefly in England, for many years, and has recently been explained by A. A. Griffith and others. For clays in a dry state, there exists a similar discrepancy between internal pressure and tensile strength. With increasing moisture content the discrepancy between internal pressure and strength rapidly decreases.

Mr. Merriman is correct, also, in stating: "To postulate a force of this magnitude (3,000 lb. per sq.in.) is a severe test for the native credulity of the uninitiated."

The postulate which Mr. Merriman tries to disprove by an appeal to "common sense" and nothing else was first passed by the board for Mathematics and Physics of the Academy of Sciences in Vienna and was published in the proceedings of the Academy in 1923.

In June, 1924, the same postulate was set forth in a paper before the International Congress for Applied Mechanics in Delft, Holland, a congress in which 250 of the leading experts of Europe participated; the paper is published in the proceedings of that congress, 1925. The physical essence of the postulate which strikes Mr. Merriman was almost instantaneously grasped by those engaged for years in the study of plastic materials, and after the lecture one of the leading experts in mathematical physics made the remark, "It is incredible that this almost self-evident fact was not realized years ago."

It may be fair to point out that, as my articles in *Engineering News-Record* represent an exceedingly brief summary of my experiments and conclusions, the proof of my statements is, necessarily, fragmentary.

Cambridge, Mass., Nov. 19, 1925. CHARLES TERZAGHI.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

City Managers Association Growing Rapidly

Increase in Membership and in Cities Having Managers—Civil Service Favored

With 358 cities in the United States and Canada operating under the city manager form of government, the International City Managers' Association at its twelfth annual convention at Grand Rapids, Mich., Nov. 17, 18 and 19, registered about one-third as many delegates. Subjects handled related largely to managerial problems with only a few topics relating directly to engineering but many of them pertaining to engineers, such as when to employ outside experts, unit costs for measuring efficiency and administration of a zoning ordinance and traffic regulation.

The movement toward the city-manager form is growing. John G. Stutz, executive secretary, indicated in his report an increase of 21 during the year, 258 adopting the form by charter, 84 by ordinance and 16 not classified. Thirty-five states have cities with this form. Michigan with 39 cities leading and Florida and California having 37 and 36 respectively. Large cities studying this form at the present time are Seattle, Oklahoma City, Denver, Minneapolis, Flint, Mich., Atlanta, Macon, Ga., Portland and Omaha. Cleveland, Kansas City and Fort Worth have recently adopted it. Of all the changes in governmental form since 1914, when only 33 cities had the city-manager form, 95 per cent have been in this direction.

Association Affairs

The association affairs since the employment of a permanent executive secretary have been put on a sound financial basis with assets of $6,092 and a net worth of $2,344. Expense of the office, which is at Lawrence, at the University of Kansas, is shared by two or three other municipal associations. Two magazines are published. The office answers 40 to 60 letters a month on the city-manager plan, 20 to 25 on administration; receives 600 first class letters and mails out 1,500. It has a library package service for members with 25 calls per month and has a budget of $21,346.

Mr. Stutz recommended appointment of a committee on research and one on city-manager apprenticeship. This was also one of three recommendations of the new services committee and referred to the executive committee for action. The idea is to duplicate the work of leading industrial and public utility companies which comb the engineering schools at graduation time for the best men to enter their employ.

(*Concluded on p. 892*)

Engineering Fifty Years Ago

From *Engineering News*, November, 1875

Water Waste

IN THE CITY of Chicago which draws its supply of water from that inexhaustible reservoir, Lake Michigan, so extravagant are the people in the use, and so willful in the waste, of the precious fluid during the entire year, but especially in the summer season, that in the remote districts of the city, the water almost entirely ceases to run at some hours of the day, and even in the very heart of the city, the water is with difficulty forced to the third stories of the houses, and hardly ever beyond. In hundreds of houses during the warm season, the water is kept running to cool the air, and from thousands of garden hose pipes, it is left to run both day and night, while from many of the private hydrants which are everywhere present in the yards of the poorer classes of people, streams are constantly flowing at full pressure, either for the amusement of crowds of urchins, or through willful neglect of turning it off by the occupants of the premises. In winter, the water runs from hydrants, both public and private, and from the pipes in almost all the houses and factories, to prevent it from freezing and so causing damage by the bursting of the pipes. The Board of Public Works has remonstrated with, and threatened, and the newspapers have lectured, the inhabitants about the matter time and again, but with little or no beneficial effect, and the only remedy that seems to be of any avail is to add more force at the pumping works until there is no lack anywhere within the limits of the water supplied districts, which remedy is being applied now in the construction of the new tunnel and pumping works in the South Division of the city.

Oregon City Votes to Continue Commission-Manager Plan

By a vote of 921 to 318 the electors of Oregon City, Ore., voted on Nov. 11 to continue the commission-manager form of government instead of returning to the councilmanic forms.

Building Problems Reviewed by Construction Council

Varied Aspects of Building Industry Seen by Architects, Contractors, Material Men and Others

"Better Buildings" was the keynote at the fourth annual convention of the American Construction Council, held in Chicago on Nov. 18 to 21, but the greater part of the proceedings related to residence buildings. This organization aims to represent all classes of construction work and all the varied interests (financial, design, construction and equipment) related to such work, but its activities are centered largely on building construction. In an address of welcome, Mr. Doherty, building commissioner of Chicago, referred to the recent controversy over hollow tile and brick as building material. Both materials are good, and he thought the work of the Council would tend to prevent such unfortunate controversies. In the presidential address of Franklin D. Roosevelt, which was read by the secretary, reference was made to the valuable work of the Council in obtaining wide press publicity as to its work and purposes in securing better building construction. This address also laid stress on the value of close co-operation between all parties interested in building construction and in improved methods and conditions in the industry.

Responsibility for Poor Work

National co-operation of such interests was discussed by E. J. Russell, architect, of St. Louis, who pointed out that this would tend to eliminate defective material and workmanship. On the other hand, much blame for defective design and construction was placed upon the loan companies by Max Baumann, New York. This condition applies particularly to large and costly buildings. Loan companies in general are content to provide the money without any investigation as to whether it is spent properly, although their profit is large enough to warrant an expenditure ample for good supervision.

Other papers discussed the responsibility of the architect, the material man, contractor, labor and apprenticeship in relation to better building. The purposes of city planning and zoning were outlined by Alfred Bettman, Cincinnati, Ohio. Building regulations and fire protection were other subjects presented, and a large part of one session was devoted to home buildings. In a series of addresses on the economic importance of building construction, Harry A. Wheeler emphasized the civic values, while W. C. Clark showed the relation of good building design to investment interests. For instance, the original plan for an office building may

be such that the rents will not warrant the proposed investment loan, while with a revised plan the rental space may be so increased and improved that the investment will be profitable. He instanced also the complications and difficulties of constructing a large building in a given time, with the numerous trades, processes and materials involved, from the foundations to the roof and then the interior finish and equipment.

WINTER WORK

Winter work was the main subject considered at a session devoted to the problem of peaks and depressions in the construction industry. Education is the best means of extending highway work for a longer season, according to Arthur H. Blanchard, president of the National Highway Traffic Association. That winter work in building construction is not only practicable but desirable was shown by W. J. Lynch, of the Thompson-Starrett Co., who listed the various advantages in regard to labor and material supply. The satisfactory results of a four-year co-operative campaign by architects, contractors, labor organizations and material men at Rochester, N. Y., to promote winter work and thus reduce costs and unemployment was reviewed by H. R. Sandholzer. This campaign has shown that much repair and alteration work can be carried on to advantage in the winter when good mechanics are available, while if it is done in the summer these men are engaged on other work. The transportation side of the seasonal problem was outlined by D. D. Conn, manager of public relations for the American Railway Association.

Papers and addresses constituted the main part of the proceedings, with very little discussion. The registration totaled nearly 200, but at some sessions there was only a small attendance. No changes were made in the officers, as those elected in 1924 have two-year terms. The president is Franklin D. Roosevelt, vice-president of the Fidelity & Deposit Co.; secretary, Dwight L. Hoopingarner, New York.

Propose to Bridge Snake River at Twin Falls, Idaho

The Dravo Contracting Co., Pittsburgh, Pa., is applying for a franchise to build and operate a suspension toll-bridge across the Snake River Canyon at Twin Falls, Idaho. Robinson & Steinman, of New York, are consulting engineers on this project. The distance across the canyon at the bridge site is approximately 1,200 ft. The hearing before the commissioners of the two counties is scheduled for Nov. 30.

Engineers to Report on Unusual Sewage Treatment Problem

How to treat the sewage so it may be used to irrigate crops without menace to those that consume them is the novel problem on which the city of Walla Walla, Wash., is to have a report made by Pearse, Greeley and Hansen, consulting engineers, Chicago.

Philadelphia Bridge Deadlock Goes to Supreme Court

The United States Supreme Court has granted permission to the state of Pennsylvania to bring suit against the state of New Jersey to compel the latter state to carry out the terms of the agreement under which the Philadelphia-Camden bridge is being constructed. New Jersey has been notified to file a reply by Jan. 25.

Drainage Congress Proposes Change in Plans

Whether the National Drainage Congress should adhere to its usual plan of an annual convention for the presentation of papers and addresses, or whether it should take active steps to encourage and assist landowners in solving and financing development problems and community enterprises, is a question which has been submitted to the directors by the president of the National Drainage Congress, E. V. Willard, consulting engineer, St. Paul, Minn. If the latter plan is to be followed, a campaign to increase the funds available will have to be undertaken. A change of name and a broadening of the activities to include drainage, irrigation and land development in general is also under consideration.

Cement Association Lays Corner Stone for Building

After 23 years existence the Portland Cement Association has decided to own a building of its own for office headquarters and laboratory. The corner stone of the new building at Grand Ave. and Dearborn St., Chicago, was laid, Nov. 18, during the week of the association's annual meeting. The structure which will be completed in May, 1926, was financed by direct appropriation and bonds sold to members. It has a ground area of 8,000 sq.ft., five stories, basement and sub-basement with concrete caisson foundations for three additional stories. The exterior is of cut concrete stone and in the interior use will be made of concrete art marble and plastered areas illustrating various decorative possibilities of portland cement.

Throughout, modern methods in concrete design and field control of quality are being followed. Mixtures are designed for definite strengths by the water-ratio principle developed at the Structural Materials Research Laboratory.

Presiding over the ceremonies was Blaine S. Smith, president of the association who introduced B. F. Affleck, chairman of the building committee, and Robert W. Lesley, first president of the association. Mr. Lesley traced the history of the organization and industry. The Structural Materials Laboratories which has been maintained for ten years at Lewis Institute will be moved to the basement of the new structure.

Holabird & Roche, Chicago, are the architects and the Turner Construction Co., New York, the builders.

Chicago Takes 20-Year Inventory of City Development

To celebrate its twenty-first anniversary the Chicago Association of Commerce last week held ten meetings (two per day) at which the comprehensive survey of the city's development, which the association has been making during the past year, was presented. Engineers were included in the survey on construction industries and physical development, although they were interested in the session on public service, which included a survey of the utilities and transportation. The idea of the survey was not entirely one of boosting the city by superlatives and a maze of statistics, but to catalog deficiencies and their remedies.

Edgar S. Nethercut, secretary of the Western Society of Engineers, representing the engineers on the committee having to do with construction and physical development, outlined the contribution of the engineers which he said could not be measured by statistics but by achievements such as the evolution of a new method, or the adoption of an established method to a new use. In Chicago he said engineers had developed methods which have contributed to the progress of practically every important nation. He then detailed examples of engineering peculiar to Chicago conditions referring to foundations, steel skeleton type of structures, bascule bridges, intake tunnels for water and ore carriers on the lakes.

In general, the deficiences as pointed out by city officials and city plan experts relate to a lack of bonding power to carry out the improvements planned. The city's share of a $100,000,000 program of special assessment work planned in 1926 is $30,000,000 with only $6,000,000 available. The most feasible suggestion was to increase the tax valuation from one-half to full valuation which would increase the bond limit to permit an additional $60,000,000 of bonds to be issued. This job of getting the money was put squarely back on the Chicago Association of Commerce. Since the Chicago per capita tax rate is $46.31 and that of New York $132; Detroit $123.37 and Cleveland $135.85, Charles H. Wacker, chairman, Chicago Plan Commission, did not feel the people would do much complaining. John J. Sloan, president, Board of Local Improvement, was emphatic in declaring for national curtailment but extension of municipal expenditures.

Iowa Water Works Officials to Meet at Dubuque

At the meeting of the Iowa Section of the American Water Works Association Dec. 2, 3 and 4, the papers scheduled will treat of the following topics: Red water, softening, laboratory control of chemical application in purification methods, descriptions of plants at Oneida, N. Y., and Marshalltown and Dubuque, Ia., water supplies in Missouri and Iowa, stream pollution, financing and placarding of roadside wells.

New Association in California to Promote Road Work

The Highway Promotion Association whose object is "to further and extend highway construction and maintenance" was organized in San Francisco recently by contractors and representatives of firms dealing in rock, gravel, cement, asphalt, construction equipment, surety bonds, etc.

The move is said to be, in part, the result of the failure of the last state legislature to provide any definite plan for adequate state highway financing and to afford a means whereby various interests identified with highway construction could co-operate in the financing of the hundreds of millions of dollars of road work yet to be done in California.

Officers of the new association are, president, Henry J. Kaiser, Kaiser Paving Co.; secretary, Roy Fellom, Pacific Street and Road Builder; treasurer, Harry Lesser, California Bridge & Tunnel Co. The twelve directors were selected from a variety of business activities in and allied with the contracting field.

Prominent Speakers at Road Builders' Convention

Last January over 16,000 delegates were registered at the Chicago convention of the American Road Builders' Association and the number next January is expected to pass 20,000. The convention program, as previously stated in last week's issue, will be divided into two sections, one of special interest to highway engineers and the other to highway contractors. Charles M. Schwab will be the speaker at the annual banquet on Jan. 13, according to William H. Connell, president of the association and acting secretary of highways, the U. S. department of highways. C. H. Markham, president of the Illinois Central R.R., will also speak at one of the meetings.

Among the subjects of special interest to engineers that will be presented and discussed are the following: Highway finance; highway location; highway routes through cities; highway safety; future development of motor vehicles; governing factors in the selection of pavement types; recent developments in concrete pavements; recent developments in bituminous pavements; highway operation and maintenance; snow removal; surface treatment of highways.

Subjects of interest primarily to highway contractors include the following: Making contracting business pay; estimating road contracts; cost accounting; contractors qualifications; operating methods; increased costs due to improper fine grading methods; relative merits of handling materials; economics of standardization of equipment; how to stop cement overrun; winter letting of road work; relations between engineers and contractors; one-sided clauses in public works specifications.

A feature of the convention will be the setting aside of one day in honor of the foreign delegates.

Building Men Discuss the Outlook for 1926

Foresee Good Year—Labor Supply and Apprentice Problems—Quantity Surveys

That the building industry in 1926 will be very active but not as active as in 1925 was the general opinion presented by building contractors from numerous cities at a meeting of the National Association of Building Trades Employers, held at Chicago on Nov. 17. In some cities, however, an even greater activity is expected. With a registered attendance of about 125, representing cities in various parts of the country, and with free and business-like discussion of subjects specifically outlined in the program, but without set speeches or addresses, the meeting was a distinct success. In a brief opening address, the president, A. E. Coleman, pointed out that all cities have the same problems in the building industry and that therefore interchange of knowledge as to experiences and conditions is helpful to the individual contractor and to the building industry.

Labor Problems

The labor problem centers on the question of production, according to O. W. Rosenthal, Chicago. At present the production is unreasonably low, but if the men would give a fair amount of work there would be little shortage of labor and little trouble about wages. None of the speakers had a good word for the five-day week, the general opinion being that its purpose is to create an artificial condition of labor shortage and high pay. The men have no objection to working overtime, and the contractor who works long hours and pays overtime is always assured of plenty of men. One speaker held that too little attention is given to the labor turnover. A contractor may employ a large force to do a job rapidly, and then discharge the men. As soon as he has another job he employs a new force.

As to labor supply, some cities have a shortage while others foresee an ample suppply. On the question of wages, a St. Paul representative took the position that these could not be settled universally, as they are governed by supply and demand. If there is a shortage of local labor, wages will go up of necessity. A Madison representative referred to the disturbance due to outside contractors coming in after agreements have been made locally and offering higher wages. Two or three cities have practically "open shop" conditions, although in one case contractors for municipal work are required to pay union wages.

Training Apprentices

The apprentice training system is not making as good progress as it ought to make, due partly to the opposition of organized labor and partly to the apathy of contractors. One member stated that many contractors regard apprentices as "too much bother," an another said the contractors were "cowardly" in being influenced by the labor opposition. It was remarked that there are not enough "white-collar" jobs, and if any young man shows a desire to learn a trade he should be encouraged in every way by both the labor interests and the employers. Mr. Rosenthal remarked that Chicago will soon have apprentice training schools that will constitute a university of building trades. On the other hand, Ohio has a very restrictive law limiting the number of trade apprentices. A St. Louis representative outlined the activity of the local bricklayers and mason contractors association in requiring its members to employ one apprentice to every four bricklayers, while a member of the Kansas state association of contractors referred to a proposed bill for the establishment of state schools for trade apprentices.

Quantity Surveys

A matter that brought out many questions was that of quantity survey systems. At Milwaukee, a survey bureau has been in successful operation for 4½ years. In Kansas, the state association of contractors has a similar bureau which is operated at a profit. In both cases there is close co-operation between the contractors, the engineers and the architects. Reference was made also to the value of local organizations in which architects, contractors and organized labor are represented, as a means of avoiding friction, particularly in such troublesome matters as jurisdictional strikes.

Keen Competition for Power Sites on Tennessee River

A public hearing is to be held by the U. S. district engineer at Chattanooga, Tenn., Dec. 15, for the purpose of considering such statements of fact or opinion as may be presented in connection with the pending applications for preliminary permits for the construction of certain power and power-navigation dams on the Tennessee River above Chattanooga and on the Clinch and Powell Rivers. Twenty-five different applications for preliminary permits on these three rivers are now pending and will be considered at this meeting. The applications are from four separate companies, the Tennessee Hydro-Electric Co. for five sites developing a total of 340,000 hp., from the Tennessee Electric Power Co. for three sites developing 177,000 hp., the Knoxville Power & Light Co. for six sites developing a total of 321,500 hp., and the East Tennessee Development Co. for eleven sites, developing a total of 592,500 hp.

Work Starts on Large Power and Pulp Project

Preliminary work has been started on the proposed dam, power house and pulp mill for the International Paper Co. on the Gatineau River at Chelsea, Que. No contract has been let for the work as the preparation of plans has not been completed but men are on the ground clearing the site and making preparations for construction.

WASHINGTON NOTES

AN appropriation is assured at the coming session to be used by the Bureau of Reclamation in co-operation with the southern states in studies of community settlements and other expedients calculated to bring about better utilization of the agricultural resources of those states. It is believed that better results can be obtained by a co-operative effort than were the federal government and the states to proceed separately. At the last session of Congress $100,000 was authorized for this purpose. It is probable, however, that the full amount will not be appropriated at this session.

Dr. Elwood Mead, the Commissioner of Reclamation, in the near future will make a trip through some of the southern states in connection with this plan.

THE President now has before him the reports of the Muscle Shoals Commission. While no part of the reports has been made public, it is understood the majority proposition follows the general line of the plan proposed in the Underwood bill which failed at the last Congress.

The minority report is thought to advocate complete separation of fertilizer and power activities, to oppose subsidy in any form or to any extent for fertilizer manufacture, and to oppose the government's entering the fertilizer business.

ACTIVE steps are about to be taken by Secretary Hoover in an effort to halt recession of the crest at Niagara Falls. Popular support for the project, which will involve works of some magnitude, is essential if legislation and international authorizations are to be obtained with reasonable promptness, it is believed. The interest in preserving the scenic beauty of the falls is thought to be sufficiently strong to assure the plan of general support from the public, both in the United States and in Canada. As no question of power is to be considered in connection with this effort to prevent further erosion no great amount of delay or difficulty is in prospect.

A LICENSE covering the project of the Nevada Irrigation District on the Yuba River in Nevada County, Calif., has been signed and delivered. It gives full rights for the use of the waters of the stream for the irrigation of agricultural lands. Incidental to the irrigation 20,000 hp. of primary power is made available at the plants of the Pacific Gas & Electric Co., the revenue for which makes possible the agricultural development.

THE Southern California Edison Co. has applied to the Federal Power Commission for a preliminary permit covering the Mohave Canyon site on the Colorado River. It is proposed to construct a concrete dam 168 ft. high at a point in the canyon 2½ miles below Topock.

State Highway Officials Meet at Detroit

Oppose Any Curtailment of Federal Aid—Favor Uniform System of Route Marking

A successful business and technical meeting of the American Association of State Highway Officials was held Nov. 18-21 at Detroit, Mich. With guests, about 300 were in attendance. A report of the technical proceedings is given elsewhere in this issue. The business proceedings occupied the final sessions on Saturday and part of the first session on Wednesday and consisted of the business and financial report of the executive secretary, the reports of the 14 standing committees and of the important committee on resolutions. The election of officers placed the following highway officials in charge of the association's work for the coming year. President Frank Page, Chairman State Highway Commission, North Carolina; Vice-President, L. D. Blauvelt, State Highway Engineer, Colorado; Secretary Frank T. Sheets, State Highway Engineer, Illinois; Treasurer, Paul Jones, Delaware State Highway Department.

Association Finances

Reviewing the business of the year, attention was directed by the executive secretary to the fact that in 16 states there had been changes in the executive officers in charge of highways. The financial statement showed receipts of $14,747.74 and expenditures of $12,629.47 leaving a balance on hand for the year of $2,118.27. In addition the treasurer's report showed funds in bank or stock holdings enough to bring the balance as of Nov. 1 to $5,019. It was stated that the official publication *American Roads* had made a profit of some $500 during the year. During the year also eleven specifications, standards and recommended practices had been submitted to either ballot and adopted. Considering Federal Aid the report said:

> The status of funds as of Nov. 1, 1925 shows that the total Federal funds available for new contracts are only a little over $53,716,000 and only a little over $11,000,000 of this amount is for funds available for contracts previous to this year.
>
> This very clearly demonstrates that any curtailment of the present authorization of $75,000,000 per year would immediately slow up the program for half of the States and would have an almost like effect upon a vast majority of the remaining States.
>
> The average yearly cash payments to the States during the past four years are $84,256,000, the average agreements for the past four years are $78,644,000. It would, therefore, seem that an authorization of $80,000,000 a year for the next two years is necessary if the road building program is to proceed without being retarded.

Resolutions

In its report on resolutions the committee besides the usual resolutions of appreciation recommended: (1) Authorization by Congress for 1928 and 1929 of Federal aid each year of $80,000,000 and $8,000,000. (2) That no reduction be made in the present mileage of Federal aid roads. (3) That a change be made in Federal aid practices providing for increasing the limits of aid in certain instances. (4) That a uniform system of marking roads be adopted. (5) That the use be generally made of the uniform questionnaire to determining responsibility of contractors as reported by the joint committee on uniform questionnaires. (6) That the State of New York and Governor Smith of that state be congratulated on the forward step taken in voting a bond issue of $300,000,000 for grade crossing elimination. (7) That the salary of the chief of the Bureau of Public Roads be materially increased.

City Managers Association Growing Rapidly

(*Concluded from p. 889*)

The apprentice committee will find managers willing to take on the men, what salaries could be paid, what class of work might be done and devise a rating system. The service committee also recommended a committee on city charter improvements and one to make a research into civil service regulations. The managers are in favor of strict civil service methods for the selection of men but not so strong for the restrictions against discharge. Ossian E. Carr, city manager, Fort Worth, said by their new civil service rules there was only one way to get in but twenty-eight to get out.

Membership

Prof. Clarence E. Ridley, University of Syracuse, in reporting on membership indicated that 74 per cent of the city managers are members, an increase of 11 per cent during the year.

C. Wellington Koiner, in his presidential address, cited the new charter for Rochester, N. Y., as the best yet drawn up. He and Mr. Stutz have just returned from the International City Congress in Brussels and a tour of European cities. Permanence in office of the municipal staffs for which men may definitely prepare themselves they contrasted with the turnover in American cities which, judging from the improvements obtained under the average commission-manager form, they estimated at 25 per cent loss in governmental and administrative efficiency plus an increased administration cost of 25 per cent.

John N. Edy, city manager, Berkeley, Calif., in his paper on "Managerial Functions of a Manager" laid down eleven rules or policies as follows: 1. Have a complete agreement with the commissioners. 2. Obtain adequate assistants. 3. Have adequate equipment. 4. Delegate work and write out instructions. 5. Maintain uniform procedures. 6. Follow up complaints consistently. 7. Be accessible to the public and employees. 8. Accept administration responsibility for all departments and not shift it onto the commission. 9. Maintain an impersonal interest in all problems. 10. Vigilantly watch to see that orders are carried out. 11. Set a personal example of right conduct of punctuality, industry, self-improvement, fairness, good character and morals.

Engineering Societies

Calendar

Annual Meetings

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C., Annual Meeting of the Highway Research Board, Washington, D. C., Dec. 3-4, 1925.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Ill., Jan. 11-15, 1926.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 14-15, 1926.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Meeting, Portland, Ore., Jan. 18-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 20-22, 1926.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Toronto, Ont., Jan. 27-29, 1926.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 23-26, 1926.

The Minnesota Federation of Architectural and Engineering Societies and the Minnesota Surveyors and Engineers Society will hold their convention at St. Paul, Minn., February 4, 5 and 6.

The Chicago Regional Planning Association will hold its third annual meeting Dec. 2 and 3 at the Sherman Hotel, Chicago. Sessions will be devoted to subdivision plotting and zoning, public health, general surveys and population forecasts, recreation facilities and highways. At the highway session the need for a regional plan will be discussed by James T. Voshell, district engineer, U. S. Bureau of Public Roads. Indiana, Illinois and Wisconsin state highway engineers will speak of their interest in the plan.

The Lake Michigan Sanitation Congress will hold it annual meeting Dec. 10 and 11 at St. Joseph, Mich. (postponed from Nov. 20 and 21). Among the speakers scheduled are: T. Chalkley Hatton, chief engineer, Milwaukee Sewerage Commission; E. D. Rich, director, bureau of engineering, Michigan State Board of Health; John W. Alvord, consulting engineer, Chicago; George G. Earl, general superintendent and chief engineer, New Orleans Sewerage and Water Board; C. M. Baker, sanitary engineer, Wisconsin State Board of Health; Langdon Pearse, sanitary engineer, Sanitary District of Chicago; George H. Fenkell, superintendent and general manager, Detroit Department of Water Supply; Prof. W. C. Hoad, University of Michigan; Harrison P. Eddy, consulting engineer, Boston; George W. Fuller consulting engineer, New York; H. F. Ferguson, chief sanitary engineer, Illinois State Board of Health, and Charles H. Hurd, consulting engineer, Indianapolis.

Personal Notes

JOHN A. FOULKS, Newark, N. J., has opened an office in the Kinney Building in Newark for consulting practice in municipal engineering and public improvements, including organization, management, investigations, plans, specifications and supervision. Mr. Foulks was until recently chief engineer of the Newark city water department, and formerly was with the New Jersey State Highway Department and the New Jersey State Civil Service Commission.

H. W. BOETZKES, formerly employed on the construction of the Catskill Aqueduct, New York, is now in Poland as general superintendent of construction on sanitary and building work for Ulen & Co. in four Polish cities. His headquarters are Aleja Ujazdowska 37, Warsaw, Poland.

GEORGE G. SCHMIDT has been named city engineer of Indianapolis to replace FRANK C. LINGENFELTER, effective January 1. Mr. Schmidt has served as deputy county surveyor and county surveyor for Marion County, of which Indianapolis is the county seat; he is now head of George G. Schmidt & Co., civil engineers and surveyors.

H. B. CASSIN, city manager, Daytona, Florida, recently submitted his resignation to the city commission. The commission, however, deferred action on the resignation, and appointed H. A. HALLAND, assistant city engineer, as assistant city manager, the plan, it is understood, being that Mr. Cassin will be retained during the remainder of his term but that his duties will be lightened. He has accepted a position as engineer for the Gordon R. Cowle Corporation, developers of a new subdivision.

NORMAN M. STINEMAN, assistant engineer, structural bureau, Portland Cement Association, has been elected a member of the board of trustees of Ohio Northern University.

SOLOMON-NORCROSS Co., consulting engineers, has been incorporated by the former associates of the late Paul H. Norcross to specialize in water supply, sewerage and hydro-electric development. The firm is composed of Col. G. R. Solomon, Frank J. Keis, Herman F. Wiedeman and M. T. Singleton. COLONEL SOLOMON, who heads the new organization, is a graduate of Rensselaer Polytechnic Institute and with Paul H. Norcross founded the original firm of Solomon-Norcross Co. in 1906, which was dissolved when he withdrew in 1918 to accept a commission in the U. S. Army. FRANK J. KEIS is a graduate of Rensselaer Polytechnic Institute and first became associated with Solomon-Norcross Co. in 1908, and, upon the withdrawal of Colonel Solomon, he became a partner, and the firm became Norcross and Keis until Mr. Keis' withdrawal in 1922. HERMAN F. WIEDEMAN is also a graduate of Rensselaer Polytechnic Institute and joined the organization in 1915. M. T. SINGLETON received his education at Georgia School of Technology and joined the organization in 1910. Mr. Wiedeman and Mr. Singleton were Mr. Norcross' principal assistant engineers at the time of his death in the "Norman" disaster near Memphis, Tenn. The new firm is retaining its Atlanta office at 1404 Candler Building, and also has established an office at Palm Beach, Florida.

Obituary

CRAWFORD LIVINGSTON died in New York City, Nov. 16, in his 78th year. Mr. Livingston was a native of New York and began railroad work as purchasing agent at St. Paul for the Winona & St. Peter Ry. Subsequently he was engaged in the financing and building of several railroads in the Northwest, including the Chicago-Great Western. For many years he was a director of the Northern Pacific Railway Co.

SIR EDWARD E. PEARSON, noted English engineer, died suddenly in London Nov. 18, at the age of 51 years. Sir Edward was a director of the firm of S. Pearson & Son, Ltd., contractors for public improvement construction, and was responsible for a number of great engineering projects, including the Malta dry dock and breakwater for the British Admiralty, port works at Valparaiso for the Chilean government, and during the War the huge munitions work at Gretna for the British government; for this last service he was knighted in 1917.

ALFRED BYRON COE, member of the firm of Coe & Nasten, civil engineers, Seattle, Wash., recently died in that city.

JOHN S. GOODELL, Amherst, Mass., civil and railroad engineer, died Nov. 14 in his 50th year of age. Mr. Goodell was born in Amherst and educated at Massachusetts Agricultural College and Rensselaer Polytechnic Institute. Much of his engineering work was in railroad construction; in 1899 he supervised this line of construction in Texas, in 1908 he was stationed in China, in 1911 in Hawaii and in Kansas in 1916.

GEORGE RABY, veteran architect of St. Louis, Mo., died Nov. 10 in the 97th year of his age. Mr. Raby was born in Manchester, England, and educated in architecture and civil engineering. He came to Canada in 1860 and practiced in both professions for eight years, being one of the architects of the Canadian Houses of Parliament. Coming to the United States he located at Quincy, Ill., and later moved to St. Louis where he practiced as an architect until his retirement in 1907.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Electric Motors and Their Lubrication

Advantages and Disadvantages of Systems Used Together With Practical Operating Suggestions

THE efficiency of the electric motor depends upon the efficiency with which its bearings are lubricated. Because the builders of electric motors have given every care to the design of their bearings with a view to rendering lubrication as automatic as possible, many operators are prone to overlook such factors as: the kind of oil to be used, the constructional details of the bearings, and the lubricating requirements imposed by virtue of the operating conditions.

From a lubricating point of view, electric motors, regardless of their type or winding, present essentially the same requirements according to the construction of their bearing lubricating system. The only wearing parts of an electric motor where lubrication is necessary are the bearings which carry the central shaft of the armature or rotor. Different motor builders have incorporated in their equipment different kinds of lubricating systems dictated for the most part by the type of bearing used and its expected operating conditions.

Ring Oiling Systems

Probably the most generally known of the lubricating systems is the ring oiler whereby oil is continually carried to the bearing surfaces from a reservoir which is part of the bearing housing by means of a ring which is suspended from the shaft dipping into the oil to a more or less extent according to the level at which the oil is carried. The oil reservoir should be of sufficient capacity so that the oil has ample opportunity to rest, thereby making possible settling of sediment and adequate cooling. As a rule, the only way in which oil in such a system is kept at the proper temperature is by radiation of heat from the exterior surfaces of the reservoir. It may be advisable at times to increase the reservoir capacity of a ring oiler and this may best be done by tapping a short length of pipe into the lower part of the bearings, covering the bottom end of the pipe with a cap.

The oil should not be carried too high in the well since its splashing may be carried into the windage and result in oil-soaked insulation which is a very frequent cause of many motor troubles. A high-grade straight mineral oil of approximately 150 to 200 sec. Saybolt at 100 deg. F. is most often used. An oil with a low cold test should be chosen wherever it is possible that the motor may have to operate under abnormally low temperatures. When higher temperatures are expected, additional viscosity to resist the thinning down action of heat will be required and under such conditions an oil of 300 to 400 sec. viscosity or even higher may be advisable.

Ball and Roller Bearings

Ball bearings can be lubricated either with oil or light grease according to the design of the bearing housings. Roller bearings can be similarly lubricated though the type and construction of the rollers must be considered in addition. The lubricant for both of these types of bearings must serve the dual purpose of both lubricating and protecting the surfaces against rusting, corrosion or abnormal wear. As a general rule, as light a lubricant should be used as can be successfully retained in such a bearing. Usually an oil with a viscosity of from 100 to 200 sec. Saybolt at 100 deg. F. will be best. Certain authorities contend that submergence of approximately ½ to ¾ of the lowest ball in a ball bearing is sufficient. In this connection, it is important to remember that contrary to the principles of plain bearing lubrication, the oil in a ball or roller bearing plays no part as a cooling agent. Therefore, volume is a detriment rather than an advantage. Where end thrust may develop to an appreciable extent on the roller bearings, a rather heavy oil is best, a straight mineral lubricating oil of as high as 750 sec. Saybolt viscosity at 100 deg. F. being recommended. The selection of heavier oils for roller bearing lubrication, however, should be carried out with utmost care for it easily is possible to develop an excess of internal friction.

Wherever there is possibility of oil leakage or under conditions of dust, dirt or dampness, it may be advisable to resort to grease as the lubricant. Greases furnish better seals against the entry of foreign material and thereby protect the bearings better. Grease can also be very much more effectively retained in a non-oiltight housing. On the other hand, dirt and grit once getting into the grease are always held in suspension, being carried back into the bearing repeatedly.

As a general rule, soap-thickened oils which are comparatively fluid in consistency will meet conditions where the lubricant must readily cover the entire surfaces of the balls or rollers. On the other hand, under conditions of high temperature it might be necessary to resort to greases of greater body to withstand the thinning-out effects of heat. It has been recommended that the housings of ball bearings be kept from ⅓ to ½ full of grease. Too much grease leads to heating and often results in melting and breaking down the grease, so that its lubricating value is destroyed. As a result further heating takes place and the operator attempts to remedy this by the addition of more grease, thus aggravating still further the cause of the trouble. Many believe that any system for introducing lubricant into a bearing housing under pressure should be avoided; it not only usually places too much oil in the housing, but may even force it past the seals and into the motor windings. Greases for ball and roller bearing lubrication should be as free from acid forming tendencies as possible.

Wick Oiling Systems

The wick system of lubrication is used in many fractional horsepower motor bearings and usually consists of an oil cup underneath the motor bearing containing a felt or candle wick which is pressed upward against the shaft with a spring. There are several other types but all are automatic in that the oiling stops and starts with the stopping and starting of the shaft or journal of the armature. In such bearings the viscosity of oil used should be from 200 to 300 sec. Saybolt at 100 deg. F.

Other small motors are equipped with the so-called waste packed and wool yarn system of lubrication. Such systems consist generally of oil wells and bearing housings practically the same as supplied for the ring oiler system of lubrication. The pressure of the waste must insure its continued contact with the shaft or journal for effective operation. Such bearings also require an oil from 200 to 300 sec. Saybolt at 100 deg. F.

Maintenance and Care

All motor-bearing lubricating systems should be flushed and cleaned at periodic intervals. Ring oiling systems will in general require more frequent attention than ball or roller bearings due to the fact that their housings are often less carefully designed. With the former, cleaning may be necessary at periods ranging from two weeks to every several months, while with ball or roller bearings once or twice a year is sufficient. Wherever grease-lubricated ball or roller bearings are used, the grease should be wiped out at the period of cleaning as flushing is generally not an entirely satisfactory procedure. The simplest way in which the housing can be cleaned out is to remove the top and bottom plug from the housing and drain out the lubricant. Then replace the bottom plug and pour kerosene, gasoline or a light lubricating oil heated to about 200 deg. F. into the top hole until it appears at the oil filler hole level. All plugs should then be replaced and the motor turned over slowly by hand a few times. After about 10 min. the kerosene can be drained out and about a half pint of clean oil poured into the housing and the motor given a few turns to distribute it. When this small quantity of oil has been removed and the bottom plug replaced, the housing is ready to be filled up to the proper oil level.

This article was abstracted from one that appeared in the October issue of "Lubrication," the publication of the Texas Co.

Business Notes

ST. LOUIS POWER SHOVEL CO., St. Louis, Mo., has recently been formed and will manufacture and sell the Conway shovels formerly handled by the Conveying Weigher Co., New York City. The National Lead Co. originally developed the electric shovel in its mines in the Flat River lead district and now holds the patents on them.

HARNISCHFEGER SALES CORP. announces the removal of its Philadelphia office and its eastern warehouse and service station, formerly located in New York, to 5102 Lancaster Ave., Philadelphia.

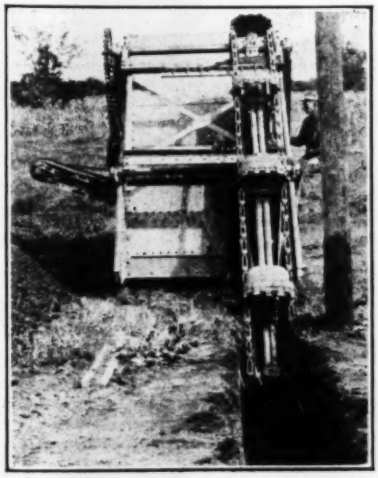
RAIL JOINT CO., New York City, announces the election of E. A. Condit, Jr., as vice-president in charge of sales.

WESTINGHOUSE ELECTRIC INTERNATIONAL CO. has just received an order from the Amtorg Trading Corp., commercial representatives of the Soviet Government in America, for 25 mine locomotives to be used in connection with the electrification of the coal mines in the Donetz district, near the Black Sea, in Russia. Part of these locomotives are of the trolley and part of the storage battery type. They will have adjustable wheel gages so that they can be operated on tracks of from 24 to 30-in. gage.

Equipment and Materials

Small Flexible Ditcher for Use in Public Service Field

A ditcher designed especially for the public service field is announced by the Parsons Co., Newton, Iowa, as its Model 21. The machine digs 12 to 24 in. wide, changing widths by inches, and to a maximum depth of 7 ft. The boom can



be shifted off center allowing the machine to dig within 7½ in. of obstructions such as telephone poles and trees. The conveyor is shifted from one side of the machine to the other while operating, insuring continuous operation while passing these obstructions. The machine can undercut or tunnel under curbs, etc., to connect with main trenches inside the parking. The digging mechanism is protected by a slip friction clutch. Positive cleaning of buckets is effected by means of an automatic cleaner.

The overall dimensions are short and the machine has a very low center of gravity. This insures stability and ability to work in cramped quarters. The three point frame suspension employed is claimed to eliminate rocking. The machine is mounted on full crawlers steered by friction clutches. Idlers mounted on rocker arms permit the crawlers to pass over obstructions without throwing the machine off line. Digging speed changes are made through heavy midship type transmissions. All operating gears are cut and housed and run in a bath of oil. Power is furnished by a heavy duty, 4 cylinder, 40 hp. motor. The weight of the machine is 14,500 lb.

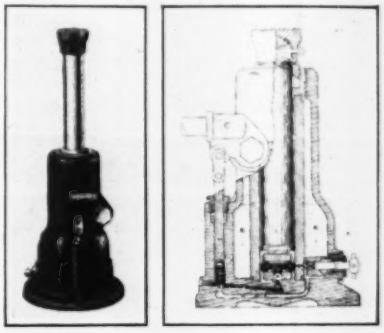
Hydraulic Principles Used on New Oil Jack

A new 10-ton jack designed on the hydraulic principle but using oil as the non-compressive liquid, known as the Pedersen "Oiljak," is being placed on the market by the Oil Jack Co., Inc., 1457 Broadway, New York City. Oil is used because it is not volatile, will remain liquid at 20 deg. below zero, is self-lubricating and preserves the leather packing that retains the oil in the jack. There are no gears, ratchets or pinions in the mechanism.

The principle of operation is best described by reference to the illustration. Raising the handle of the jack draws oil from the reservoir "R" through the channel "N" and ball check valve "B" into chamber "G." Lowering the handle compresses the oil in chamber "G," seats valve "B," forces oil past the check valve "P" into chamber "A," causing plunger "L" to rise and lift the load.

To lower, the needle valve "D" is slightly turned. This opens outlet "E" and permits oil to flow back to the reservoir. The needle valve "D" is claimed to positively control the speed of lowering, while the closing of the needle valve holds the load at any point. Likewise, discontinuing pumping at any point of a stroke, either up or down, stops the load and holds it in that position.

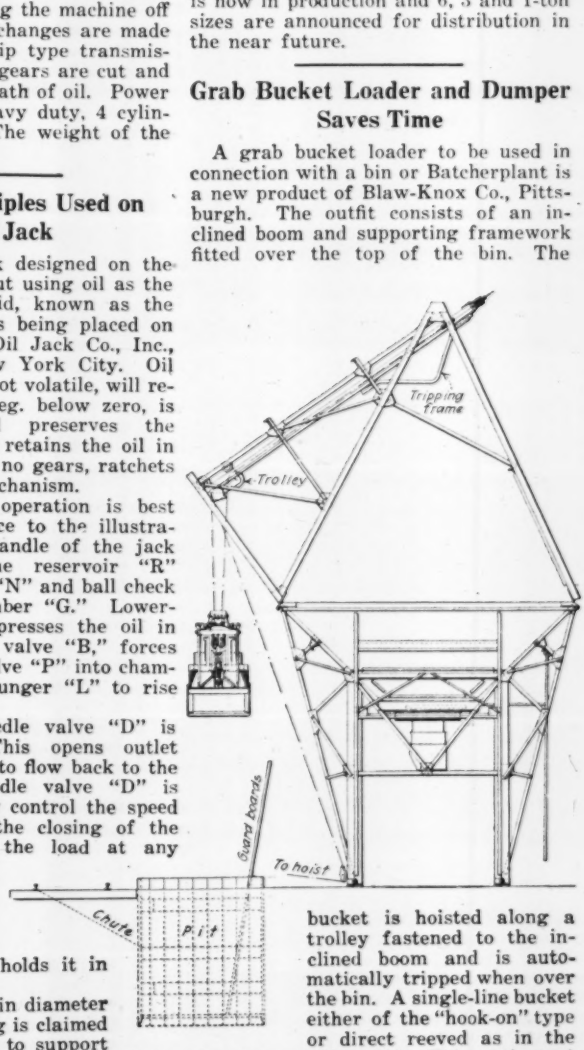
The base is 6½ in. in diameter and the entire casting is claimed to be strong enough to support many times the rated capacity of the jack. Any load within the limit of the jack's capacity is either raised or lowered without jar or shock. Moreover, the jack may be operated with little short, inch-by-inch motions of the handle if desired. A full stroke is not necessary as in the case of many other styles of jacks. This makes the Oiljak particu-



larly practical for cramped quarters or obstructed spaces. The 10-ton size is now in production and 6, 3 and 1-ton sizes are announced for distribution in the near future.

Grab Bucket Loader and Dumper Saves Time

A grab bucket loader to be used in connection with a bin or Batcherplant is a new product of Blaw-Knox Co., Pittsburgh. The outfit consists of an inclined boom and supporting framework fitted over the top of the bin. The



bucket is hoisted along a trolley fastened to the inclined boom and is automatically tripped when over the bin. A single-line bucket either of the "hook-on" type or direct reeved as in the drawing may be used. This equipment may be operated very rapidly because no time is lost in spotting the bucket either over the bin or over the supply pit. Since it takes a comparatively

short time to load the bin, the hoist operator may also operate the Batcher-plant levers that load the trucks.

Variations from the arrangement shown in the drawing may be made for any particular purpose. In some cases an extension of the inclined boom could be arranged so that the bucket could convey materials from a low level to a high level over a considerable distance.

Publications from the Construction Industry

Electric Control—GENERAL ELECTRIC CO., Schenectady, N. Y., has issued a 60-p. catalog on automatic voltage regulators. The booklet gives theory and method of operation in addition to describing the equipment used in regulating voltages on both a.c. and d.c. generators and also for speed regulation of d.c. motors. Induction voltage regulators are described for both station and outdoor operation.

Railroad Type Steam Shovels—BUCYRUS CO., South Milwaukee, Wis., has issued a new bulletin devoted exclusively to its railroad type steam shovels. The important details of the equipment are illustrated and described. Practically half of the bulletin is devoted to construction photographs featuring these shovels on construction work.

Technical Bulletins—REPUBLIC FLOW METER CO., Chicago, has begun to publish a series of articles on various technical subjects. These articles are written by authorities in their different fields and the first article of the three series so far chosen has now been published. The three series are on combustion, heat treating and ceramics. Combustion is to be treated by G. F. Gebhardt, of the Armour Institute of Technology, whose first article is on Heat Losses. Heat treating is discussed by H. M. Boylston, of the Case School of Applied Science, and his first article is entitled "The Reason for Heat Treatment." Ceramics are discussed by C. W. Parmelee, of the University of Illinois, whose first article is on "The Origin of Clays."

Snow Plows—GOOD ROADS MACHINERY CO., INC., Kennett Square, Pa., has just made available a new catalog illustrating and describing the advantages of its line of snow plows. In addition to this, the catalog is well illustrated with photos of actual snow removal operations. The several different types of plows manufactured by the company are described and a list of many present owners given.

Tractors—CATERPILLAR TRACTOR CO., San Leandro, Calif., describes its model 30, a 25-hp. machine, in a new 15-p. booklet just made available. Besides photographs and text featuring outstanding construction details, the booklet contains complete specifications for the tractor, together with a number of construction photographs showing the tractor in use in various kinds of industries.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
November 26, 1925	$14,979,000	$30,969,000	$45,948,000
November 19, 1925	12,327,000	31,523,000	43,850,000
November 27, 1924	8,789,000	10,435,000	19,224,000
Heaviest Week			
1925, Sept. 3	16,215,000	69,424,000	85,639,000
1924, May 8	26,370,000	38,829,000	65,199,000
January 1 to Date			
1925	963,501,000	1,355,577,000	2,319,078,000
1924	909,751,000	948,523,000	1,858,274,000

Unit Prices On Recent Large Jobs

Dam—Elk City, Okla.

FOLLOWING are lowest three bids opened by City, Aug. 18, for earth dam in connection with water-works systems:

	A	B	C
200,000 cu.yd. excavation	$0.56	$0.45	$0.58
1,600,000 lb. steel sheath piling	.044	.04	.0275
45,000 sq.ft. driving steel piling	.42	.40	.41
22,800 cu.yd. concrete walls and chambers	12.10	15.00	12.50
6,600 cu.yd. concrete in column struts and columns footings	16.80	16.00	21.32
7,800 cu.yd. concrete in roof and beams	14.50	17.00	18.40
12,200 cu.yd. concrete in floors	9.00	9.00	11.15
900 cu.yd. Class B concrete under east and west walls	8.00	12.00	10.00
4,870,000 lb. reinforcing steel	.038	.04	.035
650 squares waterproofing	16.20	25.00	36.00
Service gates, eight 4x6-ft. two 5-ft. circular, three 2x2-ft. (lump sum)	16,300.00	20,000.00	17,000.00
Cinder road, clearing, etc. (lump sum)	2,300.00	4,000.00	1,500.00
Gate House (lump sum)	10,800.00	7,000.00	10,250.00
528 ft. 24-in. CI pipe	8.25	9.00	3.00
600 ft. 16-in. CI pipe	4.35	6.00	4.00
1,524 ft. 12-in. CI pipe	2.90	4.00	6.25
300 ft. 8-in. CI pipe	2.15	3.00	10.50
Engineer's office (lump sum)	3,277.00	5,000.00	2,250.00
15,000 lb. steel and cast iron	.053	.07	.10
50½ ft. 8-in. steel pipe	2.50	4.00	3.00
4,877 squares asphalt roofing	6.00	5.00	9.50
Extended totals	$1,088,616	$1,160,878	$1,182,195

(A) Standard Paving Co., Tulsa (awarded contract); (B) Park & Moran, Okmulgee; (C) Ottinger & Frost, Hinton.

Reservoir, St. Louis, Mo.

BIDS were opened by Bd. Pub. Serv., Aug. 4, for reinforced-concrete covered water reservoir on Olive St. as follows:

	A	B	C
Clearing reservoir site to contour 1,873 (lump sum)	$500.00	$600.00	$750.00
49,000 cu.yd. earth embankment above subgrade, including clearing subgrade, puddle grass	.30	.25	.32
2,400 cu.yd. clay puddle below subgrade and around spillway, including earth excavation	1.00	.40	.50
790 cu.yd. plain 1:3:5 concrete corewall, collars, etc., including dowels	15.00	12.50	17.00
400 cu.yd. reinforced 1:2:4 concrete spillway and bulkhead, including joints and handrail	22.00	16.00	22.00
1,850 sq.yd. reinforced 1:2:4 8-in. slab floor of spillway	3.70	3.60	4.75
8,600 sq.yd. reinforced 1:2:4 concrete slope pavement 4-in. thick including excavation	1.75	1.85	2.75
1,600 sq.yd. local rip rap, 12-in. thick	1.25	1.40	1.75
100 sq.yd. 12-in. grouted rip rap	2.50	1.75	3.75
Extra earth excavation, per cu.yd.	.40	.22	.50
6,000 cu.yd. loose rock excavation	.75	.85	.60
4,000 cu.yd. solid rock excavation	1.75	1.70	1.20
Intake tower, including earth excavation (lump sum)	2,800.00	2,400.00	2,841.00
360 lin.ft. 14-in. CI "A" cast iron pipe in place including specials, excavation, puddle backfill	3.45	3.25	3.00
210 lin.ft. 12-in. CI "A" cast iron pipe in place including specials, excavation, puddle backfill	3.20	2.70	2.50
2 14-in. hub end gate valves and boxes	130.00	128.65	125.00
2 12-in. hub end gate valves and boxes	80.00	80.50	85.00
Extra reinforcing steel, per lb	.07	.08	.06
Extended totals	$81,279	$73,100	$92,114

(A) Missouri Eng. & Constr. Co., St. Louis; (B) Frazier Davis Constr. Co., St. Louis (awarded contract); (C) Thos. Connors & Sons, Greensburg, Pa.

Foreign Contracts Awarded to American Concerns

THE following tabulation (Table I) gives a summarization of the six most important contracts awarded to American construction organizations for work in foreign lands, since the first of the year.

In Table II are outlined four big jobs of interest to American concerns. Bids have not yet been called on these and detailed information may be obtained from the owners as the projects develop.

Table I—Contracts Let for Foreign Work

Awarded to	Address	Kind of Work	Location	Contract Value
Foundation Co.	120 Liberty St., N. Y. C.	Drainage	Macedonia, Greece.	$26,000,000
		Excavation work (subways)	England	2,500,000
		Power houses, etc.	Japan	500,000
Westinghouse Electric International Co.	150 Broadway, N. Y. C.	High tension electric transmission equipment	Tokio, Japan	2,000,000
Byrne Bros. Contr. Co	385 East 115th St., Chicago, Ill.	Streets and roads	Mexico City, Mexico.	12,000,000
Uhlen and Co.	120 Broadway, N. Y. C.	Water plant and irrigation	Athens, Greece	10,000,000

Table II—Foreign Work in Projected Stage

Proposed By	Address	Kind of Work	Location	Contract Value
Cuban Government		307 road projects; 102 new water works; 96 public buildings; 1 large drainage canal; 20 new pier	Various parts of Cuba	$300,000,000
State Department	Washington, D. C.	American Embassy	Tokio, Japan	1,250,000
The Catholic Church Authorities	Mexico City, Mexico	Cathedral	Guadalupe, Mexico	
Mexican Telephone & Telegraph Co.		Telephone extension	State of Tamaulipas, Mexico.	2,000,000

Heavy Drop in Borrowings for Municipal Improvement

LONG term state and municipal borrowings were much lighter during October than in the preceding month, according to the *Commercial and Financial Chronicle*. The total awards amounted to $75,292,998 compared with $113,946,424 in September. The aggregate borrowing in October a year ago was $92,079,368. The total of awards for October 1925 is the lowest for this month since 1922. The sales for the year to date show a decline of over $100,000,000 from the total for the ten months of last year.

Some of the larger issues placed during October were: $5,000,000 5s East Bay Utility Drainage District, Calif. water bonds; $4,104,720 4¼s Essex County, N. J. refunding; $3,000,000 4¼s Buffalo, N. Y., improvement; $2,500,000 6s Bexar, Medina-Atascosa Counties Water Improvement District No. 1, Texas, road bonds; $2,000,000 4½s, State of California; $2,000,000 4s Chicago South Park District.

The accompanying bond table shows that the rates range from 4 to 6 per cent. Most of the issues commanded a premium, while a few were placed at or below par.

Representative Public Bond Sales, October, 1925

State	Purpose	Amount	Rate per Cent	Sold For	Basis	Dated	Maturity	Purchased By
Colorado	Highway	$500,000	5	101.73	4.85	Aug. 1	1941	Bankers Trust Co. of Denver and others
Maine	Highway and bridge	600,000	4	99.8026	4.03	Nov. 1	1926-40	Harris Forbes & Co., Inc. of Boston and others
County								
Allen, Ind.	Sewer	105,325	6	100.95	.....	Sept. 11	1 to 10 yrs.	First National Bank of Fort Wayne
Broward, Fla.	Highway	300,000	5½	100.72	5.47	July 1	1935-49	Provident Savings Bank & Trust Co. and
	Court house and jail	200,000	5½	100.84	5.45	July 1	1935-49	Breed, Elliott & Harrison, Cincinnati
Boone, Ind.	Drainage	10,848	6	102.26	5.50	Nov. 10	1926-35	Farmers State Board of Lebanon and others
Clinton, O.	Road improvement	21,000	5	101.05	4.71	Sept. 1	1927-31	Seasongood & Mayer of Cincinnati
Charlotte, Fla.	Road	1,788,895	..	100	.....	.....	.....	G. B. Sawyer & Co. of Jacksonville and others
Clark, Ind.	Road	11,000	5	103.57	.....	Sept. 8	1927-36	T. D. Sheerin & Co. of Indianapolis
Daviess, Ind.	Road	11,800	4½	100.74	4.37	Sept. 15	1927-36	La Plante, Welsh and Risacher
	Highway improvement	8,200	4½	100.73	4.37	Sept. 15	1927-36	
Eureka, Nev.	Highway	38,000	5	...	.....	July 1	1927-34	Geo. W. Vallery & Co. of Denver
Essex, N. J.		4,104,720	4½	100	.....	Nov. 1	1926-50	Fidelity Union Trust Co., Newark, and others
Freeborn, Minn.	Highway	14,838	4½	100.01	4.245	Sept. 1	1936-43	Citizens Nat. Bank of Albert Lea
Genessee, Mich.	Court house	550,000	4½	100.51	4.415	Nov. 1	1928-35	Industrial Savings Bank of Flint
Hancock, O.	Road	6,800	5	100.89	4.73	Sept. 1	1927-31	H. A. Bish of Findlay
Hennepin, Minn.	Sanatorium	50,000	4½	100.84	4.27	Nov. 1	1927-31	Hennepin Co. Sinking Fund
Henry, O.	Roads	40,000	5	101.03	4.73	Oct. 1	1926-33	Stranahan, Harris & Oatis, Inc., of Toledo
Hancock, Miss.	Bridge	122,500	5½	.....	.....	July 1	1926-45	A. K. Tigrett & Co. of Memphis
Henry, Ind.	Drainage	4,947	6	101.57	5.36	June 20	1926-35	Erie C. Morgan
Jasper, Ind.	Drainage	4,929	6	100.26	5.94	June 1	1926-35	Fletcher-American Co. of Indianapolis
Kosciusko, Ind.	Road	55,000	5	103.19	4.34	Sept. 15	1926-35	Meyer-Kiser Bank of Indianapolis
	Road improvement	44,840	5	102.92	4.47	Oct. 15	1927-36	City Trust Co. of Indianapolis
Labette, Kan.	Road improvement	150,000	4½	100.52	4.39	June 1	1926-35	Fidelity Nat. Bk. & Trust Co. of Kansas City
Lake, Ind.	Building	60,000	5	102.12	4.56	July 1	1926-36	Peoples State Bk. of Crown Point
	Gravel road	54,000	5	102.54	4.54	Sept. 15	1927-36	Commercial Bk. of Crown Point
Madison, Ind.	Road	11,500	5	103.36	4.38	Oct. 15	1927-36	City Securities Corp. of Indianapolis
Mason, W. Va.	Road	70,000	5½	100.42	.....	.....	.....	Spitzer, Rorick & Co. of Toledo
Township								
Annville, Pa.		36,000	4½	102.79	4.21	Oct. 1	1930-43	Annville Nat. Bank
Economy, Pa.	Improvement	45,000	4½	101.70	4.37	Nov. 1	1932-55	Ambridge Savings & Trust Co. of Ambridge
Allegheny, Pa.	Road	15,000	5	100.36	4.92	Nov. 1	1929-31	Redmond & Co. of Pittsburgh
Ocean, N. J.	Road improvement	82,000	5	100.61	4.91	June 15	1926-41	C. W. Whitis & Co. of N. Y.
Municipal								
Aurora, Ind.	Lighting	13,500	5	100.66	4.76	Sept. 1	1926-33	City Securities Corp. of Indianapolis
Atlanta, Ga.	Street improvement	97,500	4½	100.65	4.35	Sept. 1	1927-34	The Trust Co. of Georgia of Atlanta
Albany, N. Y.	Water, pub. and street improvement	1,882,500	4½	100.4623	4.21	Oct. 1	1926-65	The Equitable Trust Co. of N. Y. and others
Buffalo, N. Y.	School	1,800,000	4½	100.61	4.23	Nov. 2	1926-45	Geo. B. Gibbons & Co., Inc. of N. Y. and others
	Park	800,000						
	Hospital	200,000						
	General hospital	200,000						
Camden, N. J.	School	586,000	4½	101.53	4.37	Nov. 1	1926-64	Bankers Trust Co. of N. Y. and others
	Water	390,000	4½	101.78	4.37			
	Improvement	354,000	4½	101.74	4.37			
Crescent City, Fla.	Paving	45,000	6	102.02	5.58	Nov. 2	1926-35	Peoples Bank of Crescent City
Cambridge, Mass.	Improvement	545,000	4½	100.8492	4.10	Oct. 1	1926-50	Eldredge & Co. of N. Y.
Canton, O.	Streets	71,285	5	101.05	4.79	Sept. 1	1927-35	Breed Elliott & Harrison of Cincinnati
Bassett, Iowa	Light and power	2,100	5	100	5	Oct. 1	1945	Fred Tucker
Dallas, Ore.	Improvement	4,244	6	103.20	5.58	Oct. 1	1935	Dallas City Bank
Hudson Falls, N. Y.	Paving	29,575	5	101.20	4.74	Aug. 1	1926-35	Peoples Nat. Bank and others
Meridian, Miss.	Streets	262,000	4½	.....	.....	July 1	1926-35	Canal-Commercial Trust & Savings Bank
Portland, Ore.	Improvement	209,647	6	105.95	5.22	Sept. 1	1935	Ab Tichner of Portland and others

Structural Steel Sales Gain

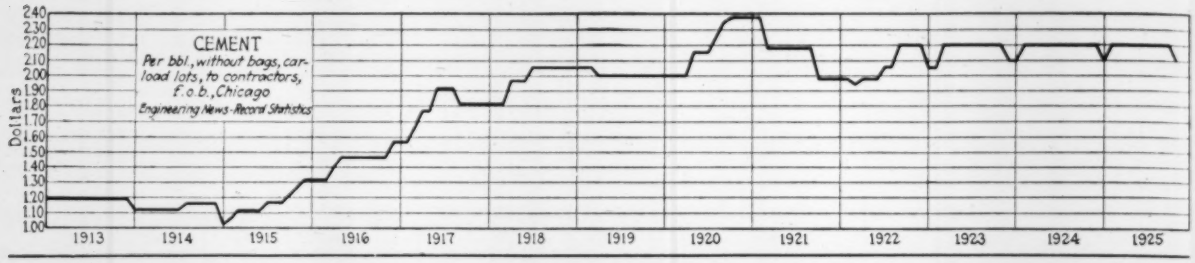
Bookings of fabricated structurals for the month of October, as computed by the Department of Commerce, totaled 255,200 tons, compared with 232,000 for the month preceding, a gain of nearly 10 per cent.

Computed tonnage for the first 10 months of 1925 totaled 2,201,100 tons, against 1,893,700 for the same months last year, a gain of 16 per cent, and 1,806,900 tons for the corresponding period in 1923, an increase of nearly 22 per cent. These figures are computed tonnages for all fabricating shops in the United States.

(*Continued on p. 898*)

Weekly Construction Market

STIFFENING of prices in steel, lumber, cement, brick and hollow tile and demand for wage increase of 14 per cent from thirty-seven building crafts are features of the week in the New York market. Demand for building materials in the Florida boom area is blamed for the unseasonal firmness here. The proposed wage scale for 1926, if adopted, would place bricklaying, the key trade, at $16 per day. Carpenters are moving for a five-day week. Mediation will probably be the next step in the wage controversy. Among the most important of the recent price changes were, advances in c.i. pipe at New York, steel pipe in Seattle, linseed oil in Denver, and common lump lime in Montreal; the principal declines occurred in lead and linseed oil at New York, cement in Milwaukee, steel shapes and rivets, crushed stone, and linseed oil in Montreal.



	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	+$4.15	$3.10	$3.35	$3.07½	$3.30	3.35	—$3.75
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	—5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	3.38	3.00	3.25	3.77½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	55%	53 6%	51%	54 25%	36%	39.2@51%	+45%	59 49
Cast-iron pipe, 6 in. and over, ton	+50.60@52.60	48 00	54 00	49.20@50.20	53 00	63.00	53.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.70	2.25	2.05	2.10	2.32	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	2.20	2.38	2.00@2.20	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.65	2.00	2.00@2.20	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.20	2.83	2.00@2.20	1.75	2.50	2.15	3.00	—1.50
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	61.00	34.00	60.00	54.50	35.75	33.75	27.00	25.00	60.00
Lime, finishing, hydrated, ton.	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl.	2.25@2.75	1.30	1.85	1.30	1.35	2.70	1.60	2.80	+10.00
Common brick, delivered, 1,000	17.50@19.50	10.50	11.10	12.00	13.50	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0893	.10	.075	.....	.075	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1027	0893	.10	.075	.07	075	.108	.10	10
Linseed oil, raw, 5 bbl. lots, gal.	— 99	1.07¼	1.13	1.01	1.11	+1.24	1.11	1.12	—1.14
Common Labor									
Common labor, union, hour.	.55@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour.	.....	.25	.30@.50	.82½	.45@.55	.35@.50	.50	.50 —	20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 55c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job; pine is 4-in. instead of 3-in.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of November 5, the next on December 3.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.156). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Structural Steel Sales Gain

(*Concluded from p. 897*)

Fabricators' bookings serve as an indicator of the trend of construction volume, particularly where bridges, tunnels, subways, ships and large buildings are concerned.

On November 1, 1925

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For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month